Senior Seminar: Future of Energy-Alternative Fuels

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Course Description

Senior Seminar courses are characterized by six essential elements:
1. A faster paced curriculum, homework will be frequent
2. An emphasis on writing, feedback, editing, and rewriting
3. Clear grading expectations and the use of scoring rubrics
4. Key outcomes of the course can be tested, measured, and evaluated. The outcomes are tied to the Knowledge and Skills for University Success (KSUS) standards.
5. An emphasis on the development of habits of the mind, such as analytical thinking and intellectual curiosity.
6. Frequent evaluation and feedback from the teacher and possibly peers. Evaluation from external sources will also be included.

This course offers students the opportunity to apply their science knowledge as they learn scientific concepts of combustion, properties of a wide variety of fuels, how to build fuel cell cars and parabolic generators and how to research alternative sources of energy. Although students who take this course would need to have already completed two years of science courses, they may not be students who want to take AP coursework. Students who take this course will learn about the process of science. The course will conclude with a student symposium of year-long projects. Mathematics will be an integral part of the content learned as students gather and analyze data, propose mathematical models and develop predictions.

Students will be expected to write, get feedback, edit, and re-write their papers. Writing expectations will be high and rubrics will be used to provide feedback to students. Research skills are also a critical component. Students will need to analyze course material critically and determine its credibility.

Students need a willingness to accept critical feedback and be open to possible failure and ambiguous learning tasks. Students will be provided with a self-evaluation checklist so they are able to assess their progress on the habits of the mind critical to college success.

Learning Outcomes

Key Prerequisite Knowledge/Skills for Success in This Course:

Mastery Level:

- Students will have completed Algebra and Geometry.
- Students will have taken two years of high school science.

Familiarity Level:

- Students should be able to write an essay with a clear opening paragraph, supporting paragraphs and conclusion. Students should be familiar with basic grammar, capitalization & punctuation, spelling, and writing conventions.
- Students should have familiarity with science inquiry skills and understand the relationship between science and society.

Outcomes of this Course

- HABITS OF THE MIND:
  1. Students will explain how mathematics is the language of science. They will add to their mathematics knowledge with skills gained in this course.

Habits of the mind are emphasized in outcomes. Independent and creative thinking is expected.

  2. Students will show the difference between hypothesis and theory and explain how "scientific theory" differs from everyday use of the term "theory" (for example a speculation or hunch). They will know that all hypotheses must be testable.

  3. Students will design testable scientific questions, refine the questions, and conduct an experiment to find solutions. They will think creatively as they develop hypothesis and estimate results.

  4. As students conduct research they will put their findings in a context that extends the work beyond the present, focusing on ideas for future scientific research.

  5. Students will learn to think independently - they will think and "do" for themselves.

  6. Students will use reasoning and analytical thinking skills. This reasoning will be supported with data rather than speculation.

  7. Students will complete a culminating project to demonstrate the topics mastered in the class. They will discuss the idea with others, ask for feedback, & accept recommendations for improvement when they are given. When the project is complete they will readily explain what they did, the specific question addressed, the results obtained, and discuss if the results supported their hypothesis(es) or not.

- KNOWLEDGE AND SKILLS

Math outcomes are critical to success in science. Understanding this integration is an important habit of the mind.

  <u>Mathematics</u>

  Students will:
  1. develop mathematical models to fit data.

2. collect data from observations and display in graphical form, including tables, graphs, and figures. Students will have a good sense of how different forms of data and information are best presented so other people can understand what they have done.

3. put data into simple spreadsheets and use as a data analysis tool. Students will draw conclusions from the data and use these conclusions in testing their hypothesis.

4. show understanding of number sense by using appropriate numbers as answers for problems and understand significant figures and uncertainties.

5. compare the data collected from the actual observations to predictions made earlier.

6. demonstrate an understanding of proportional thinking and inverse proportionality.

7. use deductive reasoning to solve problems.

8. use linear relationships, radicals, exponentials, and polynomials to analyze the data.

9. demonstrate an understanding of dimensional analysis and understand the importance of unit analysis and relationships.
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10. know when there is a statistically significant difference between two observed values.

Writing outcomes are included in this science curriculum.

Writing Skills & Research

Students will:
1. write, edit, & rewrite all papers. Students will use basic writing conventions to clearly and coherently communicate ideas, concepts and descriptions to the reader,

2. formulate a topic for research, refine the topic, develop a research plan and organize what is known about the topic.

3. demonstrate an understanding of the design of basic research.

4. effectively use research to support positions on implementation of technology.

5. understand the difference between primary and secondary sources.

6. use a variety of print and electronic sources (books, magazines, newspapers, journals, periodicals, Internet) and evaluate the sources to ascertain their credibility, origin, potential bias, and quality.

7. sort information to ascertain what to keep and what to exclude.

Reseach includes the following Habits of Mind:

Interpretation
Problem Solving
Reasoning
Constructing
Evaluating
Integrating
Precision
Checking

Science

Students will:
1. demonstrate an understanding of the scientific process: observe and identify parameters; complete a hypothesis, make predictions; experiment to test the predictions; refine the hypothesis.

2. demonstrate how to change one variable at a time in the experiment phase (parameter manipulation).

3. use technology to analyze data, including but not limited to graphing calculators, Vernier, or Logger Pro.

4. complete activities that demonstrate an understanding of energy conversions--kinetic and potential; conceptual understanding of what constitutes chemical energy, thermal energy, etc.

5. define the meaning of work, energy, and power; how they relate to one another; and apply them to real world applications.

6. describe how work is done across system boundaries, how "heat energy" is transferred across system boundaries and how "energy" is an intrinsic property of a system.

7. demonstrate an understanding of conservation of energy.

8. demonstrate an understanding of the concept of efficiency.

9. demonstrate an understanding of power density.

Students Who Are Successful in This Course are Prepared For the Following Courses

High School Level:

- If the student is not already a senior they could take AP Physics after this course.

College Level:

- Completion of this course will give students skills to be successful in introductory level science classes and Math 111 or beyond.

Textbooks & Reading Materials

Fuel Cell Car and Experiment Kit & Lab Manual
by Thames and Kosmos
Instructors and students will use current periodicals as needed. Good examples are Scientific American and Science News.
Lab activities created by the Senior Seminar team are referenced in the Schedule section of this syllabus.

Websites

http:/www.oraapt.org/resources/energy/
Global energy budget activity. Uses excel spreadsheets.

Behavior Expectations & Classroom Conduct

- Students will be active members during group and team work and will participate fully in all parts of lab activities.

Pacing and quantity of homework will mirror that of a college course.

Grading Policies

Grading policies will be designed to align with policies in the district. However, emphasis will be on rigor. The goal of this course is to provide students an exposure to what they may face in freshman level college science courses. Material will be covered at a rapid pace with the instructor offering some breaks in this rapid pace so students can evaluate effective strategies to use when the pacing is rapid.

Rubrics will be used so students have clear targets.

Scoring rubrics will be used whenever possible so students have a clear target to meeting course outcomes. Writing assignments will not be accepted until they have been edited, re-written, and re-submitted.

Culminating project will require students to explain what they did and the results obtained to outside guests with background in alternative fuels.

Evaluation will be frequent and can come from peers, the teacher, or an outside expert. The culminating project will require that the student readily explain what they did, what questions they addressed, the results obtained and if the results supported their hypothesis. Academic community guests will be asked to provide evaluative feedback to students on their projects.

Students will complete a pre & post self-evaluation checklist to assess their progress on habits of the mind.

Students will complete a checklist for college readiness to assess their own habits of the mind.

Course Schedule

Week #/ Dates:	Major Topics	Assessment(s) (Quizzes/Exams)
Pace will closely approximate that of a college level course.	FUEL CELL CARS - Scientific inquiry Pre-Lab Preparation-Concepts Needed Part I A. Different forms of energy 1. Wind 2. Solar 3. Hydro 4. Bio-diesel 5. Fossil Fuels B. Electronic Measurements 1. Current 2. Voltage 3. Resistance 4. Ohm's Law	Quiz - Formative assessment for different concepts. Short research paper on different forms of energy--writing process will be emphasized and writing rubric used to evaluate. Writing, editing and rewriting are required and writing rubrics used to grade papers.
4-5 activities	OHM'S LAW - Activities These activities incorporate a graphical version of error analysis and an understanding of Ohm's law. (See separate handout of activities)	Lab - Embedded in each activity are hypothesis, an experiment or exercise, and an analysis.
	FUEL CELL CARS - Scientific inquiry Pre-Lab Preparation-Concepts Needed Part II C. Solar Cells 1. Functionality 2. Dynamics of the Solar Panel a. Tilted b. Vertical c. Direct and Diffused Radiation d. Daily Cycle of Solar Radiation 3. Light Quantities-how much light to capture 4. Calibration of Radiation Meter 5. Graphing - Radiation vs. Current	Quiz - Formative assessment for different concepts.

Rubrics are used to grade labs--use of the scientific process will be evaluated.

Habits of Mind include:
Problem Solving
Research
Interpretation

1-3 days to complete	LIGHT WAVES - Activity Light As A Wave, Light As a Particle 1. Describing waves 2. Is light a wave? 3. Light dislodges charge from metal-- the 'photoelectric effect' 4. Light is a particle! 5. Appendix A: Light and waves 6. Appendix B: Light as particles 7. Appendix C: The photoelectric effect 8. Appendix D: Photovoltaic ('solar') cells Complete outlined assignment available.	Project - Assessment of hypothesis and answer of questions applying what was learned in answering Appendix E.
	FUEL CELL CARS - Scientific inquiry Pre-Lab Preparation - Part III D. Material Science 1. Semiconductors 2. Metal Insulators 3. PN Junction 4. Crystalline Structure of Silicon 5. Doping 5. Series and Parallel Circuits	Quiz - Formative assessment for different concepts.
	PERSONAL POWER RATING - Activity on work and energy 1. Doing work changes energy 2. Changing your gravitational potential energy 3. Doing work over time is power-ful 4. Human power ratings 5. Getting energy from power and time Complete outlined assignment available.	Lab - Evaluation of questions at end of lab.
	FUEL CELL CARS - Scientific inquiry Pre-Lab Preparation - Part IV E. Energy, Work, and Power 1. Efficiency of Cells 2. Electrolysis 3. Test for presence of Hydrogen 4. Glow test - Presence of Oxygen	Quiz - Formative assessment for different concepts.

	FUEL CELL CARS - Research A. Different Types of Fuel Cells - historical development B. Understanding the Motor 1. Operation of a Basic Motor 2. Building a Basic Motor C. Solar Cars 1. "Dream" Honda Concept Car 2. Hybrid solar-Hydrogen Car 3. New Innovations - Solid hydrogen fuel	Project - Research Assignment-Short Paper Students will be required to take notes (quoting, paraphrasing, summarizing correctly) and to use APA or MLA citations for sources. Writing process will be emphasized--students will be expected to write, edit, re-write to produce a quality paper.	Research and writing skills will be evaluated in this assignment.
	FUEL CELL CARS - Lab Materials: Wiring Assembly for Fuel Cell Gear/Motor Car Chassis Gas Collector Axles 4 Wheels & Tires Solar Panel Support for Panel Piece of Hose Digital Multi-meter Test Tubes Protective Goggles Nuts, bolts, screws, screw driver, etc Students build a fuel cell car. Lab Questions: 1. What is a fuel cell? 2. How does a fuel cell work? 3. How much water was in the fuel cell? 4. Is the solar splitting of water better than splitting with a fluorescent or incandescent lamp? 5. How long does the hydrogen remain in the tank? 6. What would be an extended application of the fuel cell? For example, can a crane operate using a hydrogen fuel cell?	Project - 1. Student will make a poster detailing the design process 2. Write a detailed report with emphasis on trouble shooting and problem solving (write, edit, re-write) 3. Power Point Presentation, incorporating digital pictures of their car during different steps of construction process	Habits of Mind include: Research Problem solving Interpretation Reasoning Presicion Checking
	PARABOLIC SOLAR GENERATOR: Estimating the Power Output Parabolas and their uses. Review of unit analysis - feet, meters, kilowatts, area measurement Can a parabolic generator be used to heat a home? If not what could it be used to heat? Complete outlined assignment available.	Project - Points will be given for accuracy of calculations used to find the power yield of the generator. Because this activity will require persistance, it is suggested that some value be placed on students willingness (if they don't get a correct answer) to revisit the procedures used, try again, and ask further questions. This is part of the learning process.	

	GLOBAL ENERGY PROJECT See website: http:/www.oraapt.org/resources/energy/ The Global Energy Budget puts students in charge of our planet's energy resosurces. By analyzing real numerical data from the past 50 years the students will see the profound impact our use of the Earth's energy resources has had upon society. Students will then be asked to use reasonable numbers to project how we will use our remaining energy sources as well as possibly develop new ones into the future. One main goal of this exercise is to utilize numbers, graphs, and the physical constraints of our planet to understand the past, present and possible futures our species can create.	Project - Energy budget scoring rubric is included in the project. See the website. Scoring rubric is designed specifically for this energy budget project.

	CULMINATING PROJECT: Symposium on Fuel Alternatives (Complete outlined project available) PART I Research groups will delve deeply into one of the following alternative fuel sources: solar nuclear wind geothermal hydrogen other (approved by instructor) Students will conduct detailed investigation to answer the following questions including supporting the answers with data from reputable sources. 1. How does the alternative fuel you chose function? For example, if you are studying solar power you will need to explain how a solar panel converts solar energy into electricity. Adapt this question to best address your chosen technology. 2. What is the current status of this technology? What portion of our energy needs are currently met by this fuel source? 3. What is the current state of research in this field? Are there any new developments in this field that promise to increase the potential of this energy source? 4. What hurdles need to be overcome in order for this technology to become a viable alternative for fossil fuel use? Why are these hurdles technically difficult- what challenges do they pose and how are we addressing them? 5 What are the advantages of using this technology instead of the current fuel sources? 6 What are the disadvantages of using this technology? Students will produce a poster and a presentation for display and presentation at the symposium at the end of the course.	Project - Grading Policy: You will be given both a group and an individual grade. Your group grade will represent 50% of your final grade and your individual grade will represent the other 50%. Group Grading (percentages listed are the percentages of the group grade derived from each category): * Division of Work (20%): How well does your group do in dividing work? Are all group members assigned responsibility for a significant portion of the task? * Use of Time (20%): Are all group members on task a majority of the time? This project will require many hours of work and you should wisely use the time provided. * Completion of Project Parts by Deadlines (20%): Are all parts of the project completed by the group on the assigned day? Every day that a component is late will result in a 10% decrease in this portion of the grade. * Presentation (40%): This portion of the grade will be based solely on the presentation at the end of the project. Components of this grade will include (but are not limited to): effectiveness of the presentation, smooth transitions between speakers, effort exerted by each group member, overall quality of the information present, advocacy of the group for their given fuel while recognizing and addressing limitations.

Culminating project will allow sharing student work with the community and the opportunity for external assessment of student work.

	CULMINATING PROJECT: Symposium on Fuel Alternatives (Project outline available) PART II Students will produce a poster and a presentation for display and presentation at the symposium at the end of the course. Poster: Your poster must contain the conclusions that you have drawn in addressing the questions from above. In class you will be shown examples of other posters that have been prepared for other research seminars. You should base your poster on these examples. Your poster must include charts and graphs to illustrate your answers to the above questions and should be constructed in an eye-catching manner. Your poster does not need to include all of the information from the research section above but should contain a concise summary of the most pertinent information for your alternative fuel. Posters must include citations for any data taken from any outside source. Presentation is discussed in Part III of this project.	Project - Individual Grading: * Use of Time (30%): How well did you as an individual use your time? It is not appropriate to procrastinate for 2 weeks on this project and then attempt to complete the necessary information in one evening. * Demonstration of knowledge (70%): How well do you as an individual demonstrate understanding of the topics that you studied? You will submit a report showing your exact contributions to this project so that your instructor may evaluate your work. This component will include both the quality and quantity of work.

	CULMINATING PROJECT: Symposium on Fuel Alternatives (Project outline available) PART III Presentation Your presentation will cover all of the questions in the research section and should have a PowerPoint component to aid in the dissemination of information. Your group of 2-3 students is responsible for a 15-20 minute presentation on your alternative fuel. In addition to answering the questions posed above, please take the following bullet points into consideration. * You should act as a proponent for your given technology. At the end of your presentation the audience should have a good sense of why it would make sense to increase the utilization of the technology. * This does not mean that you should ignore potential problems with your technology. You should address these problems and also discuss solutions to these problems. * Your presentation should include data. Data are often difficult to present during a PowerPoint presentation. You must take care to ensure that your data are presented in a clear, concise manner. You likely will not want to present all of the data you collected during your experiment. Choose the data that you present wisely- make sure the data you choose to present has meaning and importance and that you can explain exactly what these data mean. * All group members must speak- you will not receive credit for this portion of the project if you are not in attendance and don't speak during the presentation. * MOST IMPORTANTLY: You are not to read off of your PowerPoint slides. PowerPoint is used as an outline and to display images. Your audience should not have to read pages of text on the slides, nor should you simply read sentences verbatim. Please pay attention when you are given a lesson on the appropriate use of PowerPoint in a scientific setting. * The first 15 minutes of your presentation will be devoted to your research. Please save the final 5 minutes for questions from your audience.	Project - See outline in Part I and Part II of this project.