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Energy and Power Lesson Plan

Technology Integration Plan | Jennie Kies

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Unit Information

Course: Principals of Engineering
Unit Title: Energy and Power
Lesson Title: Lesson 1.2 Energy Sources
Lesson Length: 9 days – Project Lead the Way provides nine class days for Lesson 1.2 as originally written. With the modifications I describe in this integrated lesson plan, the lesson will take longer.
Grade Level: 10-12
Description of Students: Students are approximately 70% male and 30% female with an average age of 16. The class is a pre-engineering class in which students are co-enrolled at Kirkwood Community College. There is a wide variety of learning styles and attitudes present. A few students have very poor hand writing, and many prefer to use word processing software to hand writing.

Lesson Description:

Technological systems would not be possible without energy, work, and power. Although it is common to hear these terms used interchangeably in conversation, each is different and crucial to creating, using, or maintaining a technological system.

Most power used today is stored or made available when needed. In the past power that was created was often used immediately. A windmill might have been used to pump water or irrigate a field. A water wheel's rotary motion might have been used to ground grains into flour. These systems did not consist of many steps or processes between the energy source and its end use. Today's society demands that energy be stored and transported reliably and predictably to the end user. When energy and power changes form, some of it is lost along the way to elements like friction and heat. Engineers are being challenged to find creative ways to generate energy and to make systems more efficient.

In this lesson students will learn that as energy and power are converted, losses in the system will occur. Students will understand that such losses affect the overall efficiency of the system.

Goals for this Unit:

Concepts Addressed in Lesson:

1. Energy source classifications include nonrenewable, renewable, and inexhaustible.
2. Energy source processes include harnessing, storing, transporting, and converting.
3. Energy often needs to be converted from one form to another to meet the needs of a given system.
4. An understanding of work, energy, and power is required to determine system efficiency.

5. An understanding of the basics of electricity requires the understanding of three fundamental concepts of voltage, current, and resistance.
6. The atomic structure of a material determines whether it is a conductor, an insulator, or a semiconductor.

National Curriculum Standards Addressed **(click to go to listing)**

Learning Outcomes:

Students will:

· Identify and categorize energy sources as nonrenewable, renewable, or inexhaustible.

· Create and deliver a presentation to explain a specific energy source.

· Define the possible types of power conversion.

· Calculate work and power.

· Demonstrate the correct use of a digital multimeter.

· Calculate power in a system that converts energy from electrical to mechanical.

· Determine efficiency of a system that converts an electrical input to a mechanical output.

· Calculate circuit resistance, current, and voltage using Ohm's law.

· Understand the advantages and disadvantages of parallel and series circuit design in an application.

Overall Sequence for the Multiple Activity Lesson:

- Introduction
- Activity 1.2.1 – Students research the energy source of their choice with a partner.
- Activity 1.2.2 – Students research energy distribution and analyze how they use energy.
- Activity 1.2.3 – Students analyze circuits using multimeters both real and simulated.
- Activity 1.2.4 – Students apply Ohm's Law to word problems.
- Activity 1.2.5 – Students investigate energy conversion using a mechanical winch.

Introduction

Focus: Read through and address concepts, objectives, key terms, and essential questions to establish purpose. Connect the new topics with the material in Lesson 1.1 Mechanisms using the lesson description.

Activities 1.2.1 and 1.2.2

Focus: Present shorter version of Energy Sources power point.

Guided Instruction: Facilitate discussion of power point. Compare what we learned with what we still want to know using Activity 1.2.1, essential questions, concepts, and objectives as a guide.

Demonstrate good search techniques and how to create a search plan using student input to create an exemplar of the presentation. Discuss the rubric and assess exemplar.

Productive Group work: Students complete Activity 1.2.1 with a partner. Students choose the energy source they want to research and submit a research plan in their engineering notebook for teacher approval. They work together to practice good search skills and support learning the new topic of energy. Students as a group determine which question each person will answer then report to the group and compile the information into their presentation.

Independent Learning: Students complete Activity 1.2.2 as homework. Students research energy distribution to answer the questions posed in Activity 1.2.2 and analyze how they use energy.

Assessment: Activities 1.2.1 and 1.2.2 are assessed using rubrics. To conclude the activities we discuss the conclusion questions to both activities as a class and return to the essential questions, concepts, and objectives as a review of what we have learned and what we will be covering next.

Integrating Digital Technology: This project would fall in the Collaborative and Infusion cell of TIM because students use technology tools collaboratively and choose the best tools themselves.

Students work in pairs to research an energy source and create a presentation, and students choose which software meets their needs. I encourage students to use Google presentation or other collaborative web-based tool because they can collaborate from different locations on one document. Students who use power point call, text or email to work together outside of class.

In order to take this up a notch, I would require students to contact experts in the field of energy that they are researching. This would take the technology level to Transformation. In order to communicate with experts, I could provide students with contacts in higher education. Students could then use collaborative tools to interact with the experts to further their understanding and provide accurate information for their peers.

21stCentury Classrooms: The lesson plan for these activities includes assessment for learning. After students create a research plan, they discuss it with their teacher in order to get feedback. Students also participate in creating and evaluating an exemplar of the product to help them understand the target and self-assess. The teacher also manages the class by walking around, facilitating group work, and answering questions.

CyberCitizenry: I integrated the concepts from the Research unit from Common Sense Media into this lesson. The **Searching Unit Overview** describes one lesson in which students learn strategies for conducting online research. Ideally, students would have completed this lesson during their freshman year and this would be review and practice. Commonsense Media provides the following objectives for this lesson:

Students will:

• Understand the importance of using a variety of search strategies

• Master new strategies for effective and efficient online searches

• Learn to create and execute a five-step plan for conducting an online search

Universal Design for Learning: Within the Recognition Network area, I found that I am already implementing some of these strategies, which include presenting information in different ways using visual aids, demonstration and discussion. Students can re-read the power point presentations on the class website; in order to provide another means of perception, I am also trying to find a Text-to-Speech tool that I can embed in the class website. In the Strategic Network, which is the "how" of learning, allowing for different forms of communication like Prezi, video, Glogster, etc. provides students with different ways to demonstrate their knowledge. In the Affective Network, which focuses on student motivation, Project 2.1.1 provides several different areas for choice. Students choose which energy source they are interested in and have technology choices as well.

Activities 1.2.3 and 1.2.4

Focus: To conclude activities 1.2.1 and 1.2.2 we discussed the conclusion questions to both activities as a class and returned to the essential questions, concepts, and objectives as a review of what we have learned and what we will be covering next. This conclusion will also be the focus lesson for activities 1.2.3 and 1.2.4.

Guided Instruction: Present the Breadboarding and Electronics information without using the Project Lead the Way power point; instead give students disassembled breadboards and multimeters to work with as different aspects of breadboards are described. Demonstrate how to use multimeters to measure voltage and current. Find voltage, current and resistance of a practice circuit as a class. Create voltage, current and resistance (VIR) table in order to help examine the relationship between voltage, current and resistance.

Productive Group work: Assign practice problem to small groups for productive group work. Students practice using multimeters with support from each other and while teacher walks around answering questions and clarifying procedures. Using Dr. Fisher's folded paper method, each student measures the circuit and answers the question on their own, then compares with the others to determine the final answer.

Independent Learning: Assign activity Electrical Circuits 1.2.3 to be completed individually.

Guided Instruction: Using the information students found during Activity 1.2.3 and their VIR table, discuss the mathematical relationship between voltage, current and resistance to construct Ohm's Law. Complete Ohm's Law problem as a class.

Productive Group work: Assign Ohm's Law practice problem to small groups for productive group work. Using Dr. Fisher's folded paper method, each student answers the question on their own, then compares with the others to determine the final answer

Independent Learning: Assign activity Electrical Circuits 1.2.4 to be completed individually.

Assessment: Assess Activities 1.2.3 and 1.2.4 using answer keys.

Integrating Digital Technology: This activity as originally written falls under the Constructive and Adoption cell of TIM. It is in the Constructive characteristic because students are constructing relationships between the prior knowledge provided during a presentation and their own understanding of the relationship between voltage, current and resistance. It is in the Adoption phase of technology integration because students are provided a link to the online simulation without the choice to use something else.

I use this activity in my class. I present a lecture on Ohm's law in which voltage, current and resistance are defined, and we complete some practice problems using real multimeters and circuits. For the activity, students are given several circuit problems, which they build and analyze in an online simulation. The simulation application demonstrates visually how the relationship between voltage, current and resistance works.

In order to bring this activity up a notch, I describe how I would implement the activity above. I would have students complete the activity first instead of presenting the power point. This would make the activity even more Constructive and move it to the Adaptation cell of the technology spectrum. It would become a lesson in which students' use of technology tools is integral to building an understanding of a concept. I would guide students to choose from appropriate simulation tools and provide a structure in which they can determine Ohm's law on their own.

21stCentury Classrooms: Students are at the center of learning with teacher facilitating process throughout this lesson. There is cooperative and collaborative learning taking place. The teacher leads students to Ohm's Law instead of giving it out in the power point. Students are engaged in challenging work.

CyberCitizenry: This lesson does not incorporate Common Sense Media lessons.

Universal Design for Learning: Within the Recognition Network area, using a VIR chart instead of random numbers will help some students grasp the concepts behind Ohm's Law better than presenting the information in a power point. According to the National Center on Universal Design for Learning, "a graph that illustrates the relationship between two variables may be informative to one learner and inaccessible or puzzling to another" whereas "an equals sign (=) … might cause confusion to a student who does not understand what it means." Using the chart and then working together to discover Ohm's Law will help more students understand V=IR. In the Strategic Network, this part of the lesson uses scaffolding to help students learn to use multimeters and provides experience with both a hands-on multimeter and a simulated multimeter. In the Affective Network, I work to minimize the anxiety students might feel dealing with new equipment and concepts by supporting learning and providing different ways to use tools. When students encounter obstacles, they have support from the teacher and their fellow students.

Activity 1.2.5

Focus: Review activities completed and return to the essential questions, concepts, and objectives as a review of what we have learned and what we will be covering in the final part of the lesson.

Guided Instruction: Present Work, Energy and Power power point. Demonstrate how to complete practice problem.

Productive Group work: Assign practice problem to small groups for productive group work - Using Dr. Fisher's folded paper method, each student answers the question on their own, then compares with the others to determine the final answer. Students work in teams to complete Activity 1.2.5 Mechanical Efficiency. Students design and construct a model winch. They synthesize all of the work in this lesson by measuring voltage, current, resistance, distance, force, and time in order to determine the efficiency of their winch. They work together to complete conclusion questions which include:

> List and describe three factors that reduced efficiency in the winch system.
> Describe at least one strategy for making the system even more efficient.
> Explain two or more reasons why automotive engineers are concerned with eliminating inefficiency from vehicles.

Independent Learning: Assign Essential Questions and electronic portfolio as homework.

Essential Questions:

> What sources of energy are available for use? What are the benefits and drawbacks regarding efficiency, usefulness, and the environment?
> What emerging technologies are or may be on the horizon that will provide energy more efficiently?
> What are the different energy sources that are used to deliver energy to your community?
> Describe examples in your community of individuals or businesses harnessing their own energy.
> Describe where and how the electricity that reaches your home is produced.
> Describe and identify inefficient use of energy and power at home, school, or work.
> What is the relationship between resistance, current, and voltage within an electrical system?
> Explain the distinguishing characteristics between series and parallel circuits.
> Describe how to calculate the efficiency of an electrical mechanical system.

Assessment: Lesson Quiz which includes information from Lesson 1.1 Mechanisms. All quizzes and tests in this class are cumulative. Students have the opportunity to go back and retake past quizzes to help them study.

Integrating Digital Technology: This activity falls into several of the TIM cells, but I am choosing to focus on the Goal-Directed and Adoption cell. The Goal-Directed characteristic applies because students must organize their process for meeting the challenge. It is in the Adoption cell because the teacher provides procedural instructions to use technology to plan the activity.

Students are required to use all previous knowledge from the unit including Ohm's Law, measurement skills, efficiency calculations, circuit knowledge and knowledge of mechanisms from the previous unit.

They design and build an electric winch. In the past, some students did not complete the challenge because they did not plan well for the time limitations. For this activity we will spend time at the beginning discussing good project management before they begin including having each team create a Gantt chart using an online tool, which I specify.

In order to move this challenge to the Adaptation cell of the Goal-Directed characteristic, I would provide opportunities to independently use technology tools to facilitate goal-setting, planning, monitoring, and evaluating specific activities. During subsequent design activities, I will give students more freedom to choose how they complete their project management.

21stCentury Classrooms: POE students use Google Sites to maintain a portfolio for class. Some of them also use Google Documents to submit their work or collaborate on projects. The class website is their textbook with each unit divided into lessons, which contain specific concepts, key terms, objectives, essential questions, activities and power points. I also provide links to other web resources, which they can use to supplement what we are learning in class.

This lesson has clearly stated learning goals, which we reflect on several times throughout. Students work in a variety of settings including with the whole class (15 students), small group 3-4 students, partners and individually. Students have flexibility and choice in several activities. Throughout the lesson students worked on problem or project based learning. Students were involved in designing, problem solving, decision making, and investigating.

CyberCitizenry: This lesson does not incorporate Common Sense Media lessons.

Universal Design for Learning: Within the Recognition Network area, this culminating activity addresses the ability to transform accessible information into useable knowledge. Students will be able to apply the information we have learned throughout Unit 1. In the Strategic Network and in the Affective Network, I continue to implement strategies described in the previous activities.

Conclusion:

Having redesigned this unit, I believe it would be very successful. Students would enjoy and benefit from fewer lectures and more hands-on constructive learning. The biggest challenge would be the amount of time the redesigned lesson would take. The original lesson is scheduled for nine days. As I have rewritten it, it would probably take at least fifteen days. Project Lead the Way is a national curriculum with a standardized, cumulative test at the end of the year. The curriculum is very thorough and provides the concepts, key terms, essential questions and objectives that are required to be successful on the end of year exam. If I implemented this kind of strategy for each lesson, we would not cover all of the necessary material in a school year.

One of the ways I could implement some of these changes without sacrificing content would be to invert or flip the classroom. If the demonstrations and lectures were provided for students to watch as homework, I would have more time in class to provide the scaffolding and discussion described to support the 21st Century Learning and Universal Design for Learning principles. This would also support those principles by providing students with recordings they could pause and re-watch. My current practices do not always support student learning to the fullest because we have to rush through some of the content, which does not accommodate students who write slower or need more time to process.

I learned a lot about instructional development throughout this class. I found that I am already applying many of the 21st Century Learning and Universal Design for Learning principles, but that I also need to continue being aware of student learning differences and obstacles to learning. Looking back at past final project reflections, there is a theme throughout: content comes first. This particular project was easy in that regard since I was using content that I currently teach. The content is the basis of everything for this lesson and helped me determine what to keep, what to cut, and where I could provide more opportunities for my students to learn, apply and internalize the material.

This will affect my future instructional development as I continue teaching this class. It is the hardest class for both the students and me. There is so much content, but I feel that as long as I focus on the content and apply the principles we have discussed throughout this term, my students will benefit from increased motivation and higher achievement. Next year, I hope that I can implement the changes described in this lesson plan along with a flipped classroom so that less class time is focused on lecture, and students have more support during the application phases. I will also apply the principles we have learned in the other four classes I teach especially the gradual release of responsibility framework, which will help incorporate 21st Century Learning and Universal Design for Learning.

Standards and Benchmarks Addressed

Standards for Technological Literacy

Standard 1: Students will develop an understanding of the characteristics and scope of technology.

BM J:	The nature and development of technological knowledge and processes are functions of the setting.
BM K:	The rate of technological development and diffusion is increasingly rapidly.
BM L:	Inventions and innovations are the results of specific, goal directed research
BM M:	Most development of technologies these days is driven by the profit motive and the market.

Standard 2: Students will develop an understanding of the core concepts of technology.

BM X:	Systems, which are the building blocks of technology, are embedded within larger technological, social, and environmental systems.
BM Z:	Selecting resources involves trade-offs between competing values, such as availability, cost, desirability, and waste.
BM AA:	Requirements involve the identification of the criteria and constraints of a product or system and the determination of how they affect the final design and development
BM BB:	Optimization is an on going process of methodology of designing or making a product and is dependent on criteria and constraints.
BM CC:	New technologies create new processes.

Standard 3: Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.

BM G:	Technology transfer occurs when a new user applies an existing innovation

developed for one purpose in a different function.

Standard 4: Students will develop an understanding of the cultural, social, economic, and political effects of technology.

BM I: Making decisions about the use of technology involves weighing the trade-offs between the positive and negative effects.

BM J: Ethical considerations are important in the development, selection, and use of technologies.

Standard 5: Students will develop an understanding of the effects of technology on the environment.

BM H: When new technologies are developed to reduce the use of resources, considerations of trade-offs are important.

BM J: The alignment of technological processes with natural processes maximized performance and reduces negative impacts on the environment.

BM L: Decisions regarding the implementation of technologies involve the weighting of trade-offs between predicted positive and negative effects on the environment.

Standard 8: Students will develop an understanding of the attributes of design.

BM H: The design process includes defining a problem, brainstorming, researching and generating ideas, identifying criteria and specifying constraints, exploring possibilities, selecting an approach, developing a design proposal, making a model or prototype, testing and evaluating the design using specifications, refining the design, creating or making it, and communicating the processes and results.

BM J: The design needs to be continually checked and critiqued, and the ideas of the design must be refined and improved.

BM K: Requirements of a design, such as criteria, constraints, and efficiency, sometimes compete with each other.

Standard 9: Students will develop an understanding of engineering design.

BM J: Engineering design is influenced by personal characteristics, such as creativity, resourcefulness, and the ability to visualize and think abstractly.

BM K: A prototype is a working model used to test a design concept by making actual observations and necessary adjustments.

BM L: The process of engineering design takes into account a number of factors.

Standard 10: Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

BM J: Technological problems must be researched before they can be solved.

Standard 11: Students will develop abilities to apply the design process.

BM M: Identify the design problem to solve and decide whether or not address it

BM N: Identify criteria and constraints and determine how these will affect the design process.

BM O: Refine a design by using prototypes and modeling to ensure quality, efficiency, and productivity of the final product.

BM Q: Develop and produce a product or system using a design process.

Standard 12: Students will develop the abilities to use and maintain technological products and systems

BM L: Document processes and procedures and communicate them to different audiences using appropriate oral and written techniques.

BM M: Diagnose a system that is malfunctioning and use tools, materials, machines, and knowledge to repair it.

BM P: Use computers and calculators to access, retrieve, organize, process, maintain, interpret, and evaluate data and information in order to communicate.

Standard 13: Students will develop the abilities to assess the impacts of products and systems.

- **BM J:** Collect information and evaluate its quality.
- **BM K:** Synthesize data, analyze trends, and draw conclusions regarding the effect of technology on the individual, society, and environment.

Standard 16: Students will develop an understanding of and be able to select and use energy and power technologies.

- **BM J:** Energy cannot be created or destroyed; however, it can be converted from one form to another.
- **BM K:** Energy can be grouped into major forms: thermal, radiant, electrical, mechanical, chemical, nuclear, and others.
- **BM L:** It is possible to build an engine to perform work that does not exhaust thermal energy to the surroundings.
- **BM N:** Power systems must have a source of energy, a process, and loads.
- **BM M:** Energy resources can be renewable or nonrenewable.

Standard 17: Students will develop an understanding of and be able to select and use information and communication technologies.

- **BM P:** There are many ways to communicate information, such as graphic and electronic means.
- **BM Q:** Technological knowledge and processes are communicated using symbols, measurement, conventions, icons, graphic images, and languages that incorporate a variety of visual, auditory, and tactile stimuli.

National Science Education Standards

Unifying Concepts and Processes Standard K-12: As a result of activities in grades 9-12, all students should develop

- **Systems, order, and organization**
- **Evidence, models, and explanation**
- **Change, constancy, and measurement**
- **Evolution and equilibrium**
- **Form and function**

Content Standard A: As a result of activities in grades 9-12, all students should develop

- **Abilities necessary to do scientific inquiry**
- **Understandings about scientific inquiry**

Content Standard B: As a result of activities in grades 9-12, all students should develop an understanding of

- **Motions and forces**
- **Conservation of energy and increase in disorder**
- **Interactions of energy and matter**

Content Standard C: As a result of activities in grades 9-12, all students should develop an understanding of

- **Matter, energy, and organization in living systems**

Content Standard E: As a result of activities in grades 9-12, all students should develop

· **Abilities of technological design**

· **Understandings about science and technology**

Content Standard F: As a result of activities in grades 9-12, all students should develop understanding of

· **Science and technology in local, national, and global challenges**

Principles and Standards for School Mathematics

Number Operations Standard:	Instructional programs from pre-kindergarten through grade 12 should enable all students to understand, ways of representing numbers, relationships among numbers, and number systems; understand meanings of operations and how they relate to one another; and compute fluently and make reasonable estimates
Algebra Standard:	Instructional programs from pre-kindergarten through grade 12 should enable all students to understand patterns, relations, and functions; represent and analyze mathematical situations and structures using algebraic symbols; use mathematical models to represent and understand quantitative relationships; and **analyze change** in various contexts.
Measurement Standard:	Instructional programs from Pre-Kindergarten through 12th grade should enable all students to understand measurable attributes of objects and the units, systems, and processes of measurement; and apply appropriate techniques, tools, and formulas to determine measurements.
Problem Solving Standard:	Instructional programs from pre-kindergarten through grade 12 should enable all students to build new mathematical knowledge through problem solving; and solve problems that arise in mathematics and in other contexts.
Communication Standard:	Instructional programs from pre-kindergarten through grade 12 should enable all students to use the language of mathematics to express mathematical ideas precisely.
Connections Standard:	Instructional programs from pre-kindergarten through grade 12 should enable all students to recognize and apply mathematics in contexts outside of mathematics.

Standards for the English Language Arts

Standard 4:	Students adjust their use of spoken, written, and visual language (e.g. conventions, style, vocabulary) to communicate efficiently
Standard 5:	Students employ a wide range of strategies as they write and use different writing process elements appropriately to communicate with different audiences and for different purposes.
Standard 8:	Students use a variety of technological and information resources (e.g. libraries, data bases, computer networks, video) to gather and synthesize information and to create and communicate knowledge.

Return to Learning Outcomes

Resources:

(2011). *UDL guidelines. National center on universal design for learning*. Retrieved from http://www.udlcenter.org/aboutudl