LEED, Leadership in engineering and Environmental Design. Helping Student to Understand Energy and the Light Pollution

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Overview

The environmental impact on new designed buildings, construction, and operation industry is significant. Buildings annually consume more than 30% of total energy and 60% of the electricity used in United States. Power generation is a leading cause of air pollution and the single largest source of U.S. global warming emissions. Coal is the worst offender, a dirty energy source that produces less than half our electricity but nearly 80 percent of all power plant carbon emissions.[1]

This unit on electricity is intended to enhance the student's understanding of energy and light pollution; how electricity generated from fossil fuels can impact the environment beginning with extraction transportation, refining and distribution. Students will look at how to better improve on the environment as a whole by being more energy efficient and looking at other sources of energy other than fossil fuels to reduce environmental impacts. In this unit the student will gain a better understanding of LEED (Leadership in Energy and Environmental Design), light pollution from artificial life, and how to conserve energy. Students will be given real world experience on how to gather data, develop charts and spreadsheets to evaluate given information and come to logical conclusions. Look to future technology and science to improve the environment. Student will also understand that technology and science have limitations, and that people must change behaviors. Students will have to perform a number of math problems to solve a given task. Students will also be responsible for designing lighting (a new light layout in a reflected ceiling plan) in a commercial space given this newly found information.

Rationale

With the rapid decline in fossil fuels due to human consumption, there is a need to assess the realization of how these fossil fuels are impacting the global climate. Students must

become aware on how these changes impact design of building, transportation, environment and other elements that affect our everyday lives. As a CTE (Career and Technical Education) class teaching Architectural Drafting and Design, student must be aware of the growing need to design more energy efficient buildings that have less of an impact on the quality of life in their communities. Most high school students develop a better understanding of concepts through visual observation interaction, rather then through lecturing. By making project-based learning part of the exercise students are provided 21st century skills that teach them critical thinking, collaboration and communications as well as creativity. The importance of any lesson being successful is asking the right questions and carefully designing lessons to promote critical thinking and creativity. Many students also like competition as well as positive reinforcement, so providing incentives as well as positive reinforcement is very important. It is well documented that students in today's society should have a basic understanding of the four C's, critical thinking, collaboration, communication, and creativity.

Light pollution

In order to understand light pollution, students need to know what causes light pollution and what impact does it have on the environment as a whole.

Types of light pollution:

- Over-illumination
- Glare
- Light clutter
- Sky glow

Students will also look at the consequences light pollution can have on the environment, such as disruption to the ecosystems, energy waste, human health, the effects on animals, and reduction of viewing the stars in the night sky.

Waste artificial light from building sites, such as parking lots, signage, building etc., produces a glare that is directed upward to the sky or is directed off the site. Artificial light that is directed upward to the sky is called "Sky glow" impeding any one person to see the stars at night. The consequences are energy waste, effects on a number of animals, and will impact human health and psychology. This will also disrupt the ecosystem, increase atmospheric pollution and have a reduction of natural sky polarization.

Energy – What is it?

"*Energy* Is the Ability to Do Work." *Energy* can be found in a number of different forms. It can be chemical *energy*, electrical *energy*, heat (thermal *energy*), light (radiant *energy*), mechanical *energy*, and nuclear *energy*.

Potential energy – is a result of gravity pulling downwards.

Kinetic energy – is the energy of motion. It quantifies the amount of work the object could do as a result of its motion.

In order to understand energy conservation, efficiency, and sustainability, the students must understand the sources from which electricity is delivered to a building or site.

Electricity (energy) is delivered primarily through fossil fuels but the development of new technology includes solar, wind power as well as water generated energy. The electricity generated is direct current (DC), which is changed into an alternate current season (AC) by an inverter for building use. Direct current or (DC) is an electrical circuit that flows in one constant direction. Alternating current (AC) is an electrical current that changes value and direction periodically. This is important to because electricity generated is direct current (DC), which is change to alternating current (AC) by an inverter for transmission.
Electric power is generated from several sources of energy: wind, water, nuclear, fossil fuel, solar and geothermal. Other then solar, all other energy sources are produce through mechanical motion that drives electric generators. These generators convert movement into electricity. Transformers are used to step up (increase) the electrical power to very high voltages for transmission by wires over long distances. Large transformers are used to step down (decrease) the electrical power for industrial, commercial or residential use. Smaller transformers set on poles or in underground vaults are used for final distribution, delivering 120 and 240 (voltages) to residences and small buildings.

Electrical properties can be measured with instruments. Electricity units are volt, ampere and watts.
Power (energy) is measured in watts, current is equal to amperes and volts is a unit of electrical pressure that makes electricity flow through a wire. So to find power (watts) one must multiply current (amperes) by volts.

Objective

This lesson will help students develop an understanding of energy, conservation and effective artificial lighting design when it comes to a site or interior space. Students will discuss LEED, Light pollution and the basic principles of lighting design and its application for residential and commercial projects. Students will look at how a space is impacted by natural light and artificial light. Students will analyze light product information and evaluate manufacturers' products and how they may impact the environment. The students will describe and identify the usage of artificial light, including incandescent, compact fluorescent and LED. Students will look at the life expectancy for each light source as well as the amount of energy each light source requires.
Students will begin with the basic of understanding of the vocabulary, then do inquiry into the principles of energy and how it affects the environment. They will discuss what they do know about the light bulbs and what they must research.

Students will inquire as to what is needed to measure the amount of watts.

Students will apply mathematics and science to the solution of a real world problem.

Students will describe the central systems and process involved with developing the solution.

Students will develop leadership and interpersonal problem-solving skills through participation in-group activities associated with project base learning.

Students will demonstrate the computation and estimation skills necessary for analyzing data and developing reasonable scientific explanations.

Standards

All students will develop skills and understanding by citing specific textual evidence to support analysis of science and technical statements, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.

All students will develop skill and understanding on following precisely complex multi-steps procedures when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.

All students will develop skills and understanding the meaning of symbols, key terms and other domain specified words and phrases as they are used in a specific science are technical context relevant to this lesson.

All students will develop skills and understand to integrate and evaluate multiple sources of information presented in diverse formats and media in order to address a question or solve a problem.

21st Century Knowledge and Skills

Employ critical thinking skills independently and in teams to solve problems and make decisions

Strategies

Do Now

To improve on students' prior knowledge, skills, and influence one should first improve the student vocabulary. Students will research all related words associated with this lesson and have a full understanding of all acronyms and professional organizations.

Review of vocabulary, with a Prezi slides show on light pollution.

Problem solving and critical thinking are two of the methods.

Problem-Based Learning

The best way for students to learn is to experience the problems and try to solve them. "Problem-base learning refocuses our practice to what some call a learning

paradigm. PBL confronts students with a messy, ill-structured situation in which they assume the role of the stakeholder or owner of this situation. They identify the real problem and learn whatever is necessary to arrive at a viable solution through investigation." By use of real-world problems one can coach learning through probing, questioning, and challenging student thinking.

Review Prezi slides 10-16 on light pollution

- Before discussing the three types of incandescent lights, students should be invited to the board to contribute to a Pros and Cons chart for each type of incandescent light source. Even if students feel they do not know a lot of information, they should be encouraged to make inferences about the sources based on what little knowledge they know.
- Examples of each lighting source should be shown to students so they understand the difference between the types of light omitted. Compact Fluorescent may be shown, but will be further discussed in the later standards.

Writing Assignment

- Students will write a reflection on which of the three types of lighting sources they would use to provide light to a classroom. Even though most classrooms use fluorescent lights, students should still reflect on the pros and cons of this lighting source.

Comparing Natural and Artificial Light

- This makes a great partner project if time is an issue. Also, it can be differentiated for those who need a less complicated version and for those who would like a challenge.
- Using the Light Comparison Chart, have students analyze their paint chips in the classroom under the three light sources given. Once the class has finished, venture outside to analyze in natural light.
    - Explain clearly that the time of day will also affect the color of their paint chip. Students who would like an extra challenge can analyze the paint chips over the weekend at different times during the day.
- After analyzing, students will choose what rooms they would paint with the analyzed colors. They would also make suggestions for what types of lighting to be used in the room.

Summary Activity – Students write 3 questions and answers from lesson that could be used as an assessment.

Classroom Activities

Lesson #1 - Light Pollution

Context

This lesson is design for the eleventh and twelfth grade students, as an introduction to energy conservation, efficiency, and sustainability. We will look at how the built environment impacts our natural environment. This will be an introduction to USGBC (U.S. Green Building Council) and LEED. We will define what is green building, what impact it has on the natural environment and why we have the USGBC. A history of LEED as well as the rating system will also be covered. We will look at light pollution, its impact on the natural environment and applicable vocabulary associated with understanding this lesson. Students will be introduced to a number of CAD electrical symbols and commands that represent a light fixture on a site plan. The students will layout a number of exterior light fixtures on a given parking lot to emphasize the point of energy conservation. When it comes to selecting exterior light fixture light (pollution friendly) for lighting a parking lot. The student will have to understand FULL CUTOFF vs. NON-CUTOFF light fixtures.

Full cut off exterior light fixtures only allows lighting no more than 90° about the fixture. This will allow the lighting to be directed to the ground only.

Non-cutoff exterior light fixtures allows lighting to illuminate 360°, which is unrestricted distribution of light, that contributes to light pollution.

Desired Results

Given the use of the smart board / Power point presentation, PC / AutoCAD software and student / teachers' interaction. The students will have a full understanding of LEED and the rule of the USGBC, light pollution and how to prevent or change what some would perceive to be a negative impact on the natural environment when it comes to Sky glow.

Materials

The tools and material required for this lesson includes a drawing file of the parking lot, the PC / AutoCAD software, release 14 and a handout with clear direction for this exercise.

Procedures

Introduction

For the attention-getter, the teacher should show a satellite image of earth, and present to the student how the built environment exterior lighting impacts the natural environment. Today we're going to learn about light pollution, and the effect it has on the material environment. It is at this point, the teacher should

present the USGBC and LEED and how the organization (USGBC) will change how buildings are to be built in the future.

Develop Knowledge

Start with an introduction and reviews of all vocabulary related to this lesson and begin to look for a way to reduce or eliminate light pollution. Introduce light dispersement from an artificial source showing how it can be dispersed direct, indirect, and diffused. Show how lighting that is directly dispersed will eliminate light pollution.

Provide Guided Practice

During the guided practice the students will follow the teacher on AutoCAD developing basic commands and review new electrical symbols for exterior light fixtures. It is at this time the teacher should walk around the classroom and assist students with these new commands / symbols. Once the students have a basic understanding of the new commands the teacher should move onto independent application of this lesson.

Apply Understanding (Knowledge or Skill) Independently

During the independent application portion of this lesson, students will work by themselves to demonstrate their understanding on light pollution and how to select the correct exterior light fixture to be used to light a proposed parking lot per the teachers' direction. The students will look at designing the lighting for a parking lot using a number of exterior light fixtures, by choosing the most appropriate fixture that will eliminate light pollution. Using Auto CAD (Computer Aided Design) the students will be given a CAD drawing of the parking lot and drawings / specifications on a number of exterior light fixtures for which they will select the best fixtures that will completely light the parking light and prevent light pollution. The fixture will range from reflected down lights and directed down (which are the best for preventing light pollution) to Ballard 360 and adjustable flood lighting (which will contribute to light pollution).

Assessment

The assessment will take place to link the independent application portion of this lesson. The teachers you walk around the room to assist the student before the tasks to see if they have a clear understanding of the task at hand or have any questions that need to be answered. The teacher will visually observe them as well as check each completed project against a rubric. The teacher is looking for each student to complete the assignment with 100% accuracy.

Lesson #2 - Energy

Context

This lesson is designed for the eleventh and twelfth grade students, as an introduction to energy conservation, efficiency, and sustainability. We will look

at how energy is measured and the amount of energy required in illuminating three types of light bulbs. We will also look at light and the amount of lighting needed to light a space with dark wall vs. a space with light color walls.

Students will look at the Pros and Cons of each type of light source, as it pertains to commercial use as well as residential use. Examples of each lighting source should be shown in each setting to the students, so they may understand the difference between the types of light omitted and how lighting may affect a mood or how lighting can showcase items within a home or building.

Desired Results

Given the use of the smart board / Power point presentation, PC / AutoCAD software and student / teachers' interaction. The students will have a full understanding of energy, conservation, efficiency, and sustainability when it comes to lighting.

Materials

The tools and material required for this lesson includes:

- A power strip with individual on and off switches
- One **Incandescent light bulb**; two **Compact florescent light bulbs** (one cool white and one warm white and two **LED light bulbs** (one cool and one warm white).
- A power meter
- A light meter
- A PC and software

Procedures

After the introduction the students' will been given the task to evaluate three types of light bulbs, Incandescent, Compact florescent and LED. You must select the most efficient light bulb that is the most cost-effective over a one-year period, five-year period and ten-year period. You would have to note the amount of electricity used, over the same periods, the life expectancy of a bulb, and is it soft white or white when it comes to illumination. After completing the evaluation of the light bulbs, you will be given direction to design a small commercial space that requires soft and white lighting to display the store goods.

Develop Knowledge

Start with an introduction and reviews of all vocabulary related to this lesson and begin to look for ways to reduce energy. We will begin with the introduction of light dispersement from an artificial source, measuring the amount of energy over a given time frame from the source. Develop skill and understanding on following precisely complex multi-steps procedures when carrying out research, analyzing the specific results based on explanations though the research.

Provide Guided Practice

We will look at energy conservation, efficiency and sustainability when it comes to electricity. We will look at LEED, leadership in engineering and environmental design, light pollution, and new light fixtures that eliminate this problem. First we will look at how electricity is generated in direct current (DC) which changes into alternating current (AC).

The electrical measurements, when it comes to the amount of power (energy) required in lighting a lamp, is measured in watts. Current (in amperes) multiplied by potential (in volts) equal power (in watts).

Apply Understanding (Knowledge or Skill) Independently

During the independent application portion of this lesson, students will work in groups as part of a project-based learning and will conduct their own research. They were performing a number of math calculations to determine the best possible solution when choosing a light bulb. The class, with direct instruction will perform a number of scientific experiments prior to research on the three types of light bulbs to measure electrical output. These experiments as well as direct instruction provide plenty of information for students to form an opinion for solving the problem on choosing a light bulb will as well as designing the commercial and residential spaces.

Students will be instructed to research the following types of light bulbs:
100 Watts and 60 Watts in three types.
Incandescent, Compact fluorescent and LED.
The students will be asked to evaluate the light bulbs given and provide analysis on cost after one-year of usage, five-year of usage and 10 year of usage to operate the bulbs based on a four-hour daily usage.

The teacher will provide the following information:

1. PECO's rate of 9 cents per kilowatt-hour
2. Kilowatt hours = Watts x four hours / 1000
3. Life expectancy for each bulb in hours

The students are to provide words like low-cost and cost to operate the bulk and a one-year timeframe five-year timeframe and ten-year timeframe. Students will be asked to select the right light bulb for residential use over a five-year timeframe in a 10-year time frame. Then select the right light for a commercial use over the same timeframe.

Assessment

The assessment will take place to link the independent portion of this lesson. The teacher will walk around the room to assist the students before the tasks. To see if they have a clear understanding of the task at hand or have any questions that need to be answered. The teacher will visually observed them as well as check

each completed project against a rubric. The teacher is looking for each student to complete the assignment with 100% accuracy. (See attached Excel spreadsheet of light bulbs analysis.)

Annotated Bibliography / Resources

U.S. Green Building Council. "New Construction & Major Renovation. Version 2.2. Reference Guide. Third Edition October 2007." Energy and Atmosphere. Page 151-238.
This resource provides information regarding the fundamental understanding of how energy impacts the environment.

Buck Institute for Education (BIE). "Project Based Learning (PBL) Toolkit Series. PBL for 21st Century Success Teaching Critical Thinking, Collaboration, Communication and Creativity." Communication Throughout a Project with Common Core Alignment. Page 84-85.
*This resource provides an illustrated spreadsheet of Communication from project launch to presentation. *

Renewable First. What's at Stake. Power generation is the leading cause of air pollution and the single largest source of global warming emissions. www.UCSUSA.org/clean-enrgy (2015).
*This website is useful for general understanding of the effects & impacts of energy's global impact from the Union of Concerned Scientists. *

Darksky.org

Footnotes:

1. New Construction & Major Renovation, Version 2.2, Reference Guide 3rd Edition

Appendices / Standards

The 21st century skills are a set of abilities that students need to develop in order to succeed in the information age. The 21st Century Skills types are listed as follows:

Learning Skills

- Critical Thinking
- Creative Thinking
- Collaborating
- Communicating

Literacy Skills

- Information Literacy
- Media Literacy
- Technology Literacy

Life Skills

- Flexibility
- Initiative
- Social Skills
- Productivity
- Leadership

http://thoughtfullearning.com/resources/what-are-21st-century-skills

PA, Academic Standards for Reading in Science and Technical Subjects
Grades 11 –12, March 1, 2014

CC.3.5.11-12.A.
Cite specific textual evidence to support analysis of science and technical texts, attending to important distinctions the author makes and to any gaps or inconsistencies in the account.

CC.3.5.11-12.B.
Determine the central ideas or conclusions of a text; summarize complex concepts, processes, or information presented in a text by paraphrasing them in simpler but still accurate terms.

CC.3.5.11-12.C.
Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text.

CC.3.5.11-12.G.
Integrate and evaluate multiple sources of information presented in diverse formats and media (e.g., quantitative data, video, multimedia) in order to address a question or solve a problem.

CC.3.5.11-12.H.
Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text, verifying the data when possible and corroborating or challenging conclusions with other sources of information.

PA, Academic Standards for Writing in Science and Technical Subjects
Grades 11 –12, March 1, 2014

CC.3.6.11-12.E.
Use technology, including the Internet, to produce, publish, and update individual or shared writing products in response to ongoing feedback, including new arguments or information.

CC.3.6.11-12.F.
Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating understanding of the subject under investigation.

CC.3.6.11-12.G.
Gather relevant information from multiple authoritative print and digital sources, using advanced searches effectively; assess the strengths and limitations of each source in terms of the specific task, purpose, and audience; integrate information into the text selectively to maintain the flow of ideas, avoiding plagiarism and overreliance on any one source and following a standard format for citation.

CC.3.6.11-12.H.
Draw evidence from informational texts to support analysis, reflection, and research.

PA, Academic Standards for Mathematics *Grades High School March 1, 2014*

CC.2.1.HS.F.1
Apply and extend the properties of exponents to solve problems with rational exponents.

CC.2.1.HS.F.2
Apply properties of rational and irrational numbers to solve real world or mathematical problems.

CC.2.1.HS.F.3
Apply quantitative reasoning to choose and interpret units and scales in formulas, graphs, and data displays.

CC.2.1.HS.F.4
Use units as a way to understand problems and to guide the solution of multi-step problems.

CC.2.3.HS.A.13
Analyze relationships between two-dimensional and three-dimensional objects.

CC.2.3.HS.A.14
Apply geometric concepts to model and solve real world problems.

	A	B	C	D	E	F	G	H	I	J	K
1											
2				**100 watts and 60 watts light bulb analysis**							
3											
4	**Type of light bulb**	**Watts**	**Light Bulb Cost each**	**Life of bulb in hours**	**Kilowatts hours = watts x 4 hours / 1000**	**4 hours x 365 days in a year**	**Cost of Kilowatts hours for 1 year**	**PECO rate of 9 cent per Kilowatt hour * 1 year**	**1 year cost**	**5 years cost**	**10 years cost**
5	100 watts incandescent	100	$0.87	1000	0.4	1460	146	$13.14	$13.14	$65.70	$131.40
6	5000k Full Spectrum Compact fluorescent= 100W	23	$8.00	12000	0.092	1460	33.58	$3.02	$3.02	$15.11	$30.22
7	LED = 100W	18	$20.00	25000	0.072	1460	26.28	$2.37	$2.37	$11.83	$23.65
8											
9	60 watts incandescent	60	$0.87	1000	0.24	1460	87.6	$7.88	$7.88	$39.42	$78.84
10	2700k Full Spectrum Compact fluorescent= 60W	13	$5.00	12000	0.052	1460	18.98	$1.71	$1.71	$8.54	$17.08
11	LED = 60W	11	$9.00	25000	0.044	1460	16.06	$1.45	$1.45	$7.23	$14.45
12											
13											
14											
15	homedepot.com										
16	PECO rates										
17											