Course Title:
Engineering

Length:
Two-Six months
Grades 7 & 8

Schools:
Pierrepont
Union

Dated:
August 12, 2013

Amended:
June 15, 2015

GIFTED AND TALENTED DEPARTMENT
ENGINEERING MINI-COURSE GRADES 7 & 8

1. Introduction/Overview/Philosophy

The program enables students to become familiar with the basic principles or engineering and design. Working in cooperative groups, the challenge is to engineer and build the most cost effective, aesthetically pleasing or structurally sound projects possible. In addition to construction, the students also learn to maintain a task schedule and work with others to accomplish a goal.

2. Objectives

A. Curriculum objectives for Engineering
The purpose of this unit is to understand structure and function in our world. Students need to understand the problems of today, what causes them, the people and cultures affected and why the problems continue to occur. Furthermore, students should consider problems predicted for tomorrow from various viewpoints and perspectives, then work with resources available to solve them.

a. Students will be able to

1. Introduce the fundamental theme of environments as complex systems that are designed and evaluated. (8.2, 5.4, 5.10)
2. Develop a broad view of technology and its role in everyday life; (8.1, 8.2)
3. Develop an understanding of technology design. (8.1, 8.2)
4. Develop process skills in observation, data collection, categorization, problem identification, data organization, and presentation, design and evaluation. (8.2, RST 8.1, 8.2, 8.3, 8.9, 5.1, 5.3, 5.4)
5. Develop awareness of problems in the immediate environment, and responsibility for solving them (8.2, 5.1, 5.3, 5.4, 5.10)
6. Foster a sense of control in relation to everyday problems. (9.2, 8.2, 5.10)
7. The student can locate relevant primary and secondary sources, and can initiate contact with professionals and experts. (RI 8.2, RST 8.1)
8. The student can select and apply note-taking techniques appropriate for the type of information collected. (RI 8.2, RST 8.1)
9. The student can record complete bibliographic data and cite the sources of all information gathered. (RI 8.1)
10. To use divergent, flexible and innovative thinking to formulate questions about a selected topic (5.1, 5.2, 9.1, 9.2);
11. To use divergent, flexible and innovative thinking to formulate solutions to selected problems (5.1,5.2, 7.2, 9.1, 9.2);
12. Develop skills in communication and group work (9.1, 9.2);
13. Develop and refine skills in research (RST 8.1, 8.2, 8.3, 8.9)
14. Refine skills in oral and written communication skills (SL 8.1, 8.3, 8.4, 8.5, 8.6);
15. To develop skills in self-direction and independent learning (9.2).

B. NJ Core Curriculum Content Standards
Common Core ELA-Literacy
CCSS.ELA-Literacy.RI.8.1 Cite the textual evidence that most strongly supports an analysis of what the text says explicitly as well as inferences drawn from the text.
CCSS.ELA-Literacy.RI.8.2 Determine a central idea of a text and analyze its development over the course of the text, including its relationship to supporting ideas; provide an objective summary of the text.

CCSS.ELA-Literacy.SL.8.1 Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 8 topics, texts, and issues, building on others' ideas and expressing their own clearly.
CCSS.ELA-Literacy.SL.8.3 Delineate a speaker's argument and specific claims, evaluating the soundness of the reasoning and relevance and sufficiency of the evidence and identifying when irrelevant evidence is introduced.
CCSS.ELA-Literacy.SL.8.4 Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation.
CCSS.ELA-Literacy.SL.8.5 Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest.
CCSS.ELA-Literacy.SL.8.6 Adapt speech to a variety of contexts and tasks, demonstrating command of formal English when indicated or appropriate.

CCSS.ELA-Literacy.RST.6-8.1 Cite specific textual evidence to support analysis of science and technical texts.
CCSS.ELA-Literacy.RST.6-8.2 Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.
CCSS.ELA-Literacy.RST.6-8.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.
CCSS.ELA-Literacy.RST.6-8.9 Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.

Science List of Standards
5.1 (Scientific processes) All students will develop problem-solving, decision- making and inquiry skills reflected by formulating usable questions and hypotheses, planning experiments, conducting systematic observations, interpreting and analyzing data, drawing conclusions and communicating results.
5.3 (Mathematical applications) All students will integrate mathematics as a tool for problem-solving in science, and as a means of expressing and/or modeling scientific theories.
5.4 (Nature and process of technology) All students will understand the interrelationships between science and technology and develop a conceptual understanding of the nature and process of technology.
5.10 (Environmental studies) All students will develop an understanding of the environment as a system of interdependent components affected by human activity and natural phenomena.

World Languages List of Standards
7.2 (Culture) All students will demonstrate an understanding of the perspectives of a culture(s) through experiences with its products and practices.

Technology List of Standards
8.1 (Computer and information literacy) All students will use computer applications to gather and organize information and to solve problems.
8.2 (Technology Education, Engineering, and Design) All students will develop an understanding of the nature and impact of technology, engineering, technological design, and the designed world, as they relate to the individual, society and the environment.
Life and Career Education in the 21st Century
9.1 (21st century life skills) All students will demonstrate creative, critical thinking, Collaboration and problem solving skills to function successfully as global citizens and workers in diverse ethnic and organizational cultures.
9.2 (Consumer, family, and life skills) All students will demonstrate critical life skills in order to be functional members of society.

3. Proficiency levels
This mini-course is offered to students in grades 7 & 8 who have qualified for the Gifted and Talented Program.

4. Methods of Assessment
a. Student Assessment
The teacher will provide a variety of assessments, which may include, but are not limited to the following: teacher observation of individual and group exercises, class discussions, and evaluation of student products.
b. Curriculum Assessment/ Teacher Assessment
The teacher/ Gifted and Talented coordinator will review this course and continue to modify and update its content.

5. Grouping
Students self-select this mini-course in grades 7 & 8.

6. Articulation/ Scope & Sequence
Typical engineering process is design and redesign. Engineering design involves the following essential components: identifying the problem; specifying requirements of the solution; decomposing the system; generating a solution; testing the solution; sketching and visualizing the solution; modeling and analyzing the solution; evaluating alternative solutions, as necessary; and optimizing the final design.
The course may offer students the opportunity to participate in:

a) weekly "stand-alone" engineering challenges with one larger culminating challenge or
b) one large-scale challenge that will take the entire course to complete.

A. Weekly (Over a course of 8 weeks)

a. Skill Building

Early weeks of the course cover exercises designed to develop and build the skills used in the engineering design and problem-solving process.

b. Applying the Skills

For each challenge students will:

i. (Identify Problem) Decide on the real world problem that needs to be solved, and any questions that may arise in an effort to solve that problem.
ii. (Specify requirements) Figure out what constraints there are for the problem and what materials are offered.
iii. (Decompose the system) Break down the problem into more manageable parts and then decide as a group to solve those parts individually or as a whole.
iv. (Generate a solution) Use research and other sources to brainstorm, improve, and create plan. Make a plan, sketch, materials list and checklist to solve the problem.
v. (Test the solution) Perform a test of the first plan.
vi. (Evaluate and redesign as necessary) Decide on what needs to be change/adapted in order to fulfill the requirements.
vii. Write/draw a project summary.

B. Large-scale projects or competitions will have their own timeline and final products.

a. Future City Competition Sequence (5-6 months)

1. September-October
    a. Decide your Future City team format.
    b. Meet with your team(s) and introduce the program and its five components.
    c. Recruit and coordinate with your engineer mentor. If you are having trouble finding a mentor your region can help you find a mentor.
    d. Find Your Region and see if any regional trainings are scheduled.
    e. Introduce your students to SimCity™ 4 Deluxe software and begin to plan and design your Virtual City.
    f. Begin researching, outlining, and creating the rough draft of the Essay. (1000 word maximum).
    g. Start gathering recyclable materials for the physical model(s).
2. October-December
    a. Continue to design your virtual city.
    b. Start building the scale physical model of your city.
        i. Decide what portion of the city you will build.
        ii. Decide the scale of your model.
    c. Finish researching and writing the Essay.
    d. Finish and submit the Virtual City Design. Visit Find My Region for the specific due date and submission instructions.

e. Write the City Narrative describing your city of the future (500 word maximum).
f. Submit the Research Essay and City Narrative to your Regional Coordinator. Visit Find My Region for the specific due date and submission instructions.
g. Celebrate achievement of milestones and evaluate progress to date!

3. December-January
    a. Develop and practice the presentation.
    b. Continue to work on the physical model.
    c. Compete in your regional Future City Competition.

b. ISTF (4 months)

1. September
    a. Enroll teams/students identify local or national problems and then select solutions from the list of National Critical Technologies (NCT's)
    b. The students try to locate technical advisors who can help the students focus their ideas and guide their research and development.
2. Oct-Nov.
    a. Component One: Investigating the Problem
        i. Task One: Describe in detail the problem your team selected and explain why it is important for your team to investigate the problem.
        ii. Task Two: Describe how your team decided on the problem you are investigating and explain what steps you took to narrow the focus of your investigation.
        iii. Task Three: Locate and document (using facts and figures) and describe how:
            1. two geographic sites or two population groups have been affected by the problem your team identified. OR
            2. two organizations, educational institutions or research facilities are doing significant research to solve the problem your team identified.
        iv. Task Four: Document (using two different sources based on facts and figures) what effect this problem has on people's lives.
        v. Task Five: Document (using two different sources based on facts and figures) the impact the problem has on the economy of our nation or on your community.
    b. Component Two: Understanding existing science and technology
        i. Task One: Provide a history of the National Critical Technology (NCT) technical application your team is researching. Include at least three significant scientific discoveries, advances and milestones using documented facts and figures.

ii. Task Two: Identify two scientists or engineers who have made major contributions to the development of the technical application your team selected and explain how their work is related.
iii. Task Three: Explain how the technical application your team is researching is currently being used to solve the problem in Component One. Include documentation regarding at least two benefits and two limitations.
iv. Task Four: Based on what you have learned in Component Two, explain how science has advanced technology regarding the technical application your team has researched.

c. Component Three: Innovating an improvement or new use
i. Task One: Propose an original improvement or new use regarding your team's technical application. Explain in detail how it works and provide a link to your design requirement.
ii. Task Two: Explain what economic impact your team's proposed improvement or new use would have as it relates to the problem you identified in Component One.
iii. Task Three: Three Identify and describe a company, federal agency or academic research laboratory that could carry out your team's proposed new improvement or new use.
iv. Task Four: Using e-mail, obtain the opinion of a scientist or engineer about your team's proposed improvement or new use for the technical application. Add this information to your website by including the individual's name, organization, copies of the e-mail the team sent and the reply it received from its inquiry.

c. Rube Goldberg Competition (3-4 months)

1. September
   a. Enroll teams/students- decide on number of machines per class to be made dependent on students in class
   b. Students begin to brainstorm ideas and bring in materials to class to use. Students ask for parent mentors to help cut materials/purchase anything needed. Create a supply list for items to be purchased by G&T.
2. October-November
   a. Students work to create Rub Goldberg Machine in class.
3. December
   a. Students video tape machine and create written report. Entry and all paperwork sent in to competition by end of month.

7. Resources

A. **Speakers**
Speakers may be recruited depending on the topics selected.

B. **References**

1. Current news articles/editorials
2. On-line sources
3. Selected research books

C. **Texts**

There is no text for this course. Students solve problems provided by the Future City/ISTF specifically for that year.

Problems may also be obtained from pbskids.org (Design Squad and Zoom), TryEngineering.org, Engineering Interact, MiddleSchoolScience.com, eweek.org, balsabridge.com, nsf.gov, TeachEngineering.org,.egfi-k12.org, rubegoldberg.com, futurecity.org

8. Methodologies

Methods include but are not limited to:

- Cooperative learning
- Individual and group research
- Individual and group problem solving
- Inquiry
- Class discussion
- Brainstorming
- Critical Thinking
- Experimenting

9. Suggested Activities

- Team-building activities
- Skill-building activities
- Exploring multiple intelligences
- Researching
- Experimenting

10. Interdisciplinary Connections

The scope of materials for this engineering unit is broad and interdisciplinary. Problems from the environment, different cultures, countries, and different perspectives are examined. The engineering challenges/Future City presents problems to the students to solve that are interdisciplinary in nature. Students are also encouraged in creativity as they prepare their solution. As a team activity, Engineering encourages individual responsibility and cooperation among team members.

11. Differentiated Instruction

Differentiating instruction is a flexible process that includes the planning and design of instruction, how that instruction is delivered, and how student progress is measured. Teachers recognize that students can learn in multiple ways as they celebrate students' prior knowledge. By providing appropriately challenging learning, teachers can maximize success for all students.

Examples of Strategies and Practices that Support
Students with Disabilities

- Use of visual and multi-sensory formats

- Use of assisted technology
- Use of prompts
- Modification of content and student products
- Testing accommodations
- Authentic assessments

Gifted & Talented Students

- Adjusting the pace of lessons
- Curriculum compacting
- Inquiry-based instruction
- Independent study
- Higher-order thinking skills
- Interest-based content
- Student-driven
- Real-world problems and scenarios

English Language Learners

- Pre-teaching of vocabulary and concepts
- Visual learning, including graphic organizers
- Use of cognates to increase comprehension
- Teacher modeling
- Pairing students with beginning English language skills with students who have more advanced English language skills
- Scaffolding
- word walls
- sentence frames
- think-pair-share
- cooperative learning groups
- teacher think-alouds

12. Professional Development

As per the PDP/100 Hours statement: the teacher will continue to improve expertise through participation in a variety of professional development opportunities. Specialized professional development for teachers in the Gifted and Talented Department is offered through the Bergen County Consortium of Teachers of the Gifted (BCCTG), the New Jersey Association for Gifted Children (NJAGC), and Montclair State University G/T Youth Program