CEDAR, Inc.

TEACHER COAL STUDY UNIT PROGRAM

2005 – 2006
School Year

FIRST PLACE
NINTH - TWELFTH
GRADES

GEORGE DIAMOND
PIKE COUNTY CENTRAL HIGH SCHOOL
PIKE COUNTY SCHOOLS
PIKE COUNTY, KENTUCKY

The Design and Operation of a Surface Coalmine

I. INTRODUCTION

The students in our advanced mathematics and AP Calculus classes were asked to help determine the topic for this year's coal study unit. Each group was asked to generate a list of topics they would most like to investigate in this years coal unit. The students came up with the following list: 1. Underground Coalmine operation and design. 2. Coal transportation. 3. Surface mine operation and design 4. Coal preparation. The classes discussed each of the topics in some detail and voted for their favorite topic. The clear winner was "surface mine operation and design". The class decided that since our school was constructed on property that had previously been surface mined it would be a perfect location to investigate various aspects of surface mining. Students were asked to imagine the property in its pre-mined condition and to think of the steps or activities that were needed to mine the coal on this property.

After determining the topic for this years Coal Study Unit it was decided that the unit should contain several elements. First, the unit should be broad enough to include all academic departments at the school and involve the participation of as many students as possible. Second, the unit should emphasis contextual learning. Students that are engaged in hands-on learning activities will be much more likely to retain what they have learned. Third, the unit should challenge students to solve real world problems encountered in coal mining. They should have to think critically, use problem-solving skills and be engaged at the highest levels of Blooms Taxonomy. Fourth, the unit should address all six Kentucky Learning Goals, most core content in each academic area, and should satisfy specific elements in our school consolidated plan (see coal study unit outline).

The students in the class decided that the goal of their coal study unit would be the design and operation of a surface coalmine. They wanted to investigate the use of technology and simulations in the preplanning, design, and coal separation phases of surface mining. The students in our advanced math, technical applied, and pre-calculus math classes were divided

into groups of four and tasked with designing a surface coal mine. Each group would be responsible for naming the mine, designing the mine, and describing its characteristics

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The unit addressed the following major objectives: The student will

1. Be able to use Calculus techniques to estimate the amount of overburden at the mine site to within 15% of the accepted value.
2. Use core drilling data and geostatistical techniques of Inverse Distance and Delauney Triangulation, to predict the height of the coal seam at a gas well located on the property to within two foot of the accepted height.
3. Use the polygonal method accurately estimate the volume of coal in the coal seam and determine its current market value.
4. Use Surfer 8 computer software to estimate the volume of coal in the coal seam to within 10% of the accepted value.
5. Use Kriging computer simulation software to estimate the volume of coal in the coal seam to within 10% of the accepted value.
6. Use Kriging computer simulation software to correctly draw at least two different 2-dimensional pictures of the coal seam.
7. Use Kriging computer simulation software to correctly draw at least two different 3-dimensional pictures of the coal seam.
8. Analyze the ash, moisture, BTU, and sulfur content of the coal that is mined at the site to within 8% of the accepted value.
9. Correctly use technology as a tool to assist in making decisions about the development and operation of the surface mine.
10. Correctly research the history of surface mining in Eastern Kentucky using at least 2 sources.
11. Given the material, bake a cake or pastry that correctly models the coal seam and the surrounding rock strata.
12. Given the necessary tools, be able to compose the music and/or lyrics of a song that is at least 3 minutes long and has coal as a central theme.
13. Given the materials, construct a 2-dimensional or 3-dimensional work of art that illustrates surface mining and its impact on the people of our area.
14. Be able to write a proficient short story or poem that has coal as the central cluster theme.

There are fifteen essential questions that were realized in this unit:

1. How can I use Integral Calculus to calculate the volume of the overburden.
2. What is the volume and current value of the coal located at the property?
3. If there were a gas well on the property, how would you use core drilling data to predict the height of the coal at the well?
4. What is the procedure used in writing a coal lease agreement?

5. How has surface mining impacted the lives of the people in Eastern Kentucky Kentucky?
6. How do you determine the ash, moisture, sulfur, and BTU content? of the coal mined at the site?
7. How can technology be used in the design and operation of surface mines?
8. How do you write a song about coal mining?
9. How is coal used in as a theme in different types of art?
10. How do you write a short story or essay about coal?

II. ACTIVITIES AND GOALS

This coal study unit was an interdisciplinary integration project involving all academic departments at the school. It was integrated horizontally across all subject areas in such a way that the student participated and became part of a total immersion learning activity. The student practiced cooperative learning and peer teaching skills by collaborating with and working with other students in small groups. They used critical thinking and problem solving skills to make decisions concerning the design and operation of surface mines while applying and transferring previously learned skills to solve real life problems faced in today's surface mines. The following is a brief description of the learning activities implemented in each subject area at our school.

A. Mathematics

Math students used fictional core drilling data to get a numerical picture of the coal seam. They then used the polygonal method to determine the amount and value of the coal located at the mine site. They also placed a gas well on their land track and used the surrounding core drilling data to predict the height of the coal at that location using techniques inverse distance method and Delauney Triangulation. They then used this data to calculate the ratio of the volume of the overburden to the volume of coal at the site. This is called the surface mine ratio. We also used ordinary kriging techniques to calculate the volume of the coal and predict the coal seam height at the gas well. This was accomplished using Surfer 8 Simulation software.

B. Science

Chemistry students performed coal analysis on the coal found at our mine site. This included tests for ash content, moisture, BTU, and calorific values. This was done after reviewing laboratory methods and safety procedures with each class.

C. Pre-Engineering

Students enrolled in our pre-engineering curriculum calculated the amount of coal in the coal seam and the volume of overburden at the surface mine. They also used the Surfer 8 contouring and 3-D mapping software to estimate the volume of coal on the land track. They used the kriging and inverse distance to a square function of the Surfer 8 software to draw 2-dimensional and 3-dimensional maps of the coal seam.

D. English

Junior and Senior English students wrote short stories and portfolio papers with coal as the central cluster theme.

E. Social Studies

Students enrolled in Political science classes conducted research on the history of surface mining in Kentucky. They also wrote the coal lease agreement that would have allowed the company to commence mining operations.

F. Technology

Technology was used in every academic area as a powerful tool to solve complex problems and make important decisions concerning our surface mine. The application of technology in this unit was both challenging and relevant to the problems faced in surface mining. A list of some important types of technology used in our unit would include: SurPac Vision Mine Design Software, computers, Surfer 8 3-D Mapping Software for Scientists and

Engineers, graphing calculators, VCR, TV camcorders, sound mixers, digital camera, mapmaking hardware, and the internet.

G. Art

The art department had students produced 2-dimensional and 3-dimensional works of art with coal as the central theme.

H. Music

Music students composed and recorded songs about various aspects of coal mining and its impact on the people of Eastern Kentucky.

I. Food Services

Students in the culinary skills classes made a dessert or pastry that illustrated a 3-dimenaional cut-a-way view of the coal seam and the surrounding rock strata. The then shared these with other students and faculty within the school community.

III. SUMMARY

This year's coal study unit was a resounding success. It met or exceeded all four criteria mentioned in the introduction. It involved the active participation of seventeen teachers, one administrator, and 406 students. It successfully exposed the participants to most preplanning and design aspects of surface mining. The students learned in a contextual manner using hands on activities that helped them retain what they learned, thus becoming active learners in a coal related integration project involving all academic areas. Students participating in the unit were engaged at the highest levels of Blooms Taxonomy: analysis, synthesis, and evaluation. They were asked to judge the success of the entire unit and make recommendations for improvements.

Students participating in the unit were asked to judge and critique each other's culminating projects. They listed two things they liked about the project and one area in which

the project could be improved. These evaluations became a valuable tool that many students used in improving their projects.

The participating teachers and the unit coordinator evaluated the effectiveness of the unit based upon the degree to which the unit met or exceeded the KERA Academic Expectations, taught students the high school core content, covered the program of studies, and met components of our schools improvement plan. It was apparent to all participants that this unit met all the expectations that we had originally set for the unit.

The only component of our coal study unit that would need improvement is the participation of our industrial arts department. Their participation was limited to manufacturing components and material for other students to use in their coal projects. If the unit is taught again we would like to see this department participate in a more meaningful manner that would be more relevant to surface mining.

Participating teachers in each department evaluated their students using one or all of the following methods.

I. Formative Evaluation
    a. Daily oral questions of students by the teacher
    b. Oral presentations
    c. Investigation and group product evaluations
    d. Open-response questions
    e. Quizzes
2. Summative Evaluation
    a. Culminating activity
    b. Unit examinations

The activities taught in this unit were designed to allow students the opportunity to learn in the type of multiple intelligence and learning style that best suited their needs. These styles included linguistic, logical mathematical, spatial, musical, bodily kinesthetic, interpersonal, and intrapersonal. All the participating teachers were able to differentiate their instruction to meet

the needs of students containing IEP modifications. These include special education students, 504 students, and students in our gifted and talented program.

The responses of the students and teachers that participated in this unit have been overwhelmingly favorable. They believe that their understanding of surface mine design and preplanning has been enhanced. They indicated that they especially liked the hands-on nature of the activities and enjoyed participating in the cooperative learning / peer teaching aspects of the unit.

In conclusion, our coal study unit must be considered a total success because the goal set for the unit was achieved. The fourteen objectives were either met or exceeded and the four criteria set forth in the introduction were all realized. Student learning was enhanced. Their critical thinking and problem solving skills have been improved. Most importantly, these students will take with them a greater understanding of surface mine design and preplanning, an appreciation of the difficult job performed by coal miners, and a realization of how important surface mining is to Pike County, the state of Kentucky, and the United States of America.

LESSON PLAN

Date: January 1 – May 1, 2006 **Teacher:**
Type: ☐ Daily ☒ Unit Length: __75__ (# days) **Class :**

THEME/ORGANIZER:

The Design and Operation of a Surface Coalmine

TARGET STANDARD(S): (Expressed in High Order Thinking Skills, "HOTS"/Williams and Blooms Taxonomies)
The students will be able to:

1. **Be able to use Calculus techniques to estimate the amount of overburden at the mine site to within 15% of the accepted value.**
2. **Use core drilling data and geostatistical techniques of Inverse Distance and Delauney Triangulation, to predict the height of the coal seam at a gas well located on the property to within two foot of the accepted height.**
3. **Use the polygonal method accurately estimate the volume of coal in the coal seam and determine its current market value.**
4. **Use Surfer 8 computer software to estimate the volume of coal in the coal seam to within 10% of the accepted value.**
5. **Use Kriging computer simulation software to estimate the volume of coal in the coal seam to within 10% of the accepted value.**
6. **Use Kriging computer simulation software to correctly draw at least two different 2-dimensional pictures of the coal seam.**
7. **Use Kriging computer simulation software to correctly draw at least two different 3-dimensional pictures of the coal seam.**
8. **Analyze the ash, moisture, BTU, and sulfur content of the coal that is mined at the site to within 8% of the accepted value.**
9. **Correctly use technology as a tool to assist in making decisions about the development and operation of the surface mine.**
10. **Correctly research the history of surface mining in Eastern Kentucky using at least 2 sources.**
11. **Given the material, bake a cake or pastry that correctly models the coal seam and the surrounding rock strata.**
12. **Given the necessary tools, be able to compose the music and/or lyrics of a song that is at least 3 minutes long and has coal as a central theme.**
13. **Given the materials, construct a 2-dimensional or 3-dimensional work of art that illustrates surface mining and its impact on the people of our area.**
14. **Be able to write a proficient short story or poem that has coal as the central cluster theme.**

ESSENTIAL QUESTION(S):

1. **How can I use Integral Calculus to calculate the volume of the overburden.**
2. **What is the volume and current value of the coal located at the property?**
3. **If there were a gas well on the property, how would you use core drilling data to predict the height of the coal at the well?**

4. What is the procedure used in writing a coal lease agreement?
5. How has surface mining impacted the lives of the people in Eastern Kentucky?
6. How do you determine the ash, moisture, sulfur, and BTU content of the coal mined at the site?
7. How can technology be used in the design and operation of surface mines?
8. How do you write a song about coal mining?
9. How is coal used in as a theme in different types of art?
10. How do you write a short story or essay about coal?

DIFFERENTIATED INSTRUCTION: *(Place initials of students beside modifications needed)*

IEP Modifications:

- [x] Extended Time
- [x] Reading Assistance
- [ ] Preferential Seating
- [x] Oral Assessment
- [ ] Highlight Information to be Learned
- [ ] Other *(Explain)*
- [x] Individualized Assistance
- [x] Reduced Work
- [x] Modified Grading
- [x] Use of Calculators
- [x] Slow the Rate of Presentation

GT Modifications:

- [x] Additional Instruction and Assistance
- [x] Enrichment Activities
- [x] Research
- [ ] Other

Multiple Intelligencies:

- [x] Linguistics
- [x] Spatial
- [x] Logical/Mathematical
- [x] Musical
- [x] Bodily/Kinesthetic
- [x] Interpersonal
- [x] Intra-personal
- [x] Naturalist/Outdoors
- [ ] Other

Learning Styles:

- [x] Verbal
- [x] Active
- [x] Auditory/Verbal
- [x] Kinesthetic
- [x] Sensing
- [x] Sequential
- [x] Reflective
- [x] Introversion
- [x] Extraversion
- [x] Reflective
- [x] Visual
- [x] Intuitive
- [x] Global

Cooperative Learning:

- [x] Jigsaw
- [ ] Think-pair-share
- [ ] Other

Other:

LESSON PLAN

PROCEDURES:

MATHEMATICS

1. **Students will be placed in cooperative learning/peer teaching groups and assigned the task of designing a core drilling pattern for our mine site.**
2. **Students will work in groups of four to determine the surface mine ratio at the mine site.**
3. **Each group will use the methods of inverse distance and delaunay triangulation to predict coal seam height at a specific point by using core drilling data.**
4. **Each group will use the polygonal method to estimate the volume of coal at the mine site and determine its current market value.**
5. **Each group will verify the height of the coal seam using Surfer 8 computer software.**
6. **Students in the AP Calculus class will work in groups of four to calculate the amount of overburden at the mine.**

SCIENCE

1. **Review laboratory methods and safety procedures with class.**
2. **Students will be placed in a group with 3 other lab partners and assigned the task of determining the ash, moisture, BTU, and sulfur content of a sample of coal.**

PRE-ENGINEERING

1. **Each group will calculate the amount of overburden.**
2. **Students will use the Surfer 8 contouring software to determine the volume of coal in the coal seam.**
3. **Each group will produce at least four 2 and 3-dimensional pictures of the coal seam using the Surfer 8 software.**

ENGLISH

1. **Classes were assigned the task of writing a short story, poem, or essay involving coal as a central cluster theme.**

SOCIAL STUDIES

1. ***Students were taken to the library to research the history of surface mining in our area.***
2. **Each student had to write a report on surface mining and its impact on the people of our area.**
3. **Political science students were placed in groups of 4 and assigned the task of writing the coal lease agreement for the property.**

LESSON PLAN

ART

1. Students were assigned the task of producing a drawing or painting about coal mining or one that illustrates how coal mining has impacted the Eastern Kentucky area.

MUSIC

1. Students in the band and chorus classes will compose a song or write a musical play with coal as a central theme.

HOME ECONOMICS

1. Students will work with a partner to bake a cake or pastry that illustrates the coal seam and the surrounding rock strata.

Review of Previous Lesson:

ENABLING KNOWLEDGE

MATH

1. Understand variance and central tendency.
2. Apply right triangle trigonometry.
3. Solving matrix equations and evaluating 3x3 determinants by expansion of minors.
4. Graphing in 3-dimensions.
5. Calculate area and volume of polyhedrons.
6. Use a graphics calculator.

SCIENCE

1. Understand the scientific method.
2. Follow basic experimental procedure.
3. Understand and follow lab safety rules.
4. Understand and apply basic concepts from algebra and geometry.
5. Balance chemical equations.

PRE-ENGINEERING

1. Apply right triangle trigonometry.
2. Graph in 3-dimensions.
3. Use a graphics calculator.
4. Calculate area and volume of polygons.

ENGLISH

1. Write a short story or essay.
2. Construct a paragraph.

LESSON PLAN

SOCIAL STUDIES

1. Use the internet to research a topic.
2. Construct a report and document sources.

ART

1. Understand the basics of drawing.
2. Be able to use a camera and develop film.
3. Paint with acrylic or oil.

MUSIC

1. Read and sing written music.
2. Use recording instruments.
2. Compose a musical composition.

HOME ECONOMICS

1. Understand simple baking techniques.

Manipulatives/Materials/Resources:

Calculators, rulers, protractors, compass, overhead projector, tape, graph paper, lined paper, scissors, TV., VCR, flat square, string, straightedge, graphics calculators, digital camera, Bunsen burner, beakers, graduated cylinders, computers, simulation software, drawing paper, paint, brushes, pencils, wall paper paste, mapping hardware, camcorders, sound mixers, engineering texts, and lab manuals.

Enrichment Activities/Learning Extensions:

Compare dust control at a surface mine to ventilation requirements at an underground coalmine.

Culminating Activities:

Coal Fair Projects

Review of Objectives in this Lesson:

Definitions and concepts introduced in this unit.

Assessment(s): *(Attach to Lesson Plan)* (F=Formal I=Informal)

[f] Multiple Choice	[f] Open Response	[i] On Demand	[f] Rubric
[f] Writing Portfolio	[f] Activity	[f] Quiz	[f] Test
[f] Graphic Organizer	[ ] Other (Explain):		

LESSON PLAN

Scoring Guide: [x] Yes [ ] No *(Attach to Lesson Plan)*

Technology Utilized:

[x] Overhead Projector [x] Digital Camera [x] Scanner [x] Computer [ ] Databases

[x] Scan Converter [x] Word Processor [x] Power Point [x] Spreadsheet [x] Internet

[ ] Distance Learning [x] Graphs/Charts/etc. [x] Calculators [x] Graphing Calculators

[x] Other

Pike County Central Comprehensive School Improvement Plan:

1a, 1b, 1c, 1d, 3a, 3c, 3d, 3e, 4a, 4d, 4c, 4d, 4e, 4f, 4g,

Literacy Action Plan:

1. Expand vocabulary specific it advanced mathematics.
2. Utilize power verbs in instruction and assessment.
3. Implement reading, writing, and organizing techniques in instruction.
4. Implement reading strategies to improve comprehension and reading speed.
5. Read to students and assign reading materials.
6. Parents will be contacted whenever a student is in danger of failing a course.
7. Graphic organizers will used in instruction.

LESSON PLAN

Content Specific Vocabulary:

Additional Information:

A. ACADEMIC EXPECTATIONS

Mathematics:	1.5, 1.6, 1.7, 1.8, 1.9, 2.7, 2.8, 2.9, 2.10, 2.11, 2.12, 2.13, 5.1, 5.2, 5.3, 1.11, 1.12, 5.5, 6.1, 6.2, 6.3
Science:	2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 5.1, 5.2, 5.13, 5.3, 5.5, 6.1, 6.2, 6.3
Social Studies:	2.15, 2.16, 2.18, 2.19, 2.20, 5.1, 5.2, 5.5, 6.1, 6.2, 6.3
Music:	1.14, 2.22, 2.23, 2.25, 5.1, 6.1, 6.2
Art:	1.13, 2.22, 2.23, 2.25, 5.1, 6.1, 6.2
English:	1.1, 1.11, 1.12

B. CORE CONTENT

Mathematics:	1.1.1, 1.1.3, 1.2.1, 1.2.2, 1.2.3, 1.3.2, 1.3.4, 2.1.1, 2.1.2, 2.1.3, 2.1.4, 2.1.5, 2.2.2, 2.2.3, 2.2.4, 2.2.6, 2.2.7, 2.3.1, 2.3.2, 2.3.4, 3.1.2, 3.1.3, 3.2.1, 3.2.2, 3.2.3, 3.2.4, 3.2.5, 3.3.2, 3.3.4, 4.1.4, 4.1.2, 4.1.3, 4.1.4, 4.1.5, 4.1.6, 4.2.1, 4.2.2, 4.2.3, 4.2.4, 4.2.8, 4.3.1, 4.3.2, 4.3.5
Science:	1.2.5, 1.3.1, 1.3.2, 1.4.1, 1.5.2, 1.5.3, 2.1.1, 2.2.2, 2.3.3, 3.4.1, 3.4.2
Sc. Studies:	1.1.3, 2.3.1, 3.1.1, 3.2.3, 3.4.3, 3.4.4, 4.1.3, 4.4.2, 5.1.1, 5.1.3, 5.3.6
Music:	AH-H 1.1.12, AH-H 1.1.13, AH-H 1.1.34
Art:	AH-H 4.1.41, AH-H 4.1.3.2, AH-H 4.2.32, AH-H 4.1.33
English:	WR-H 1.3, WR-H 1.4

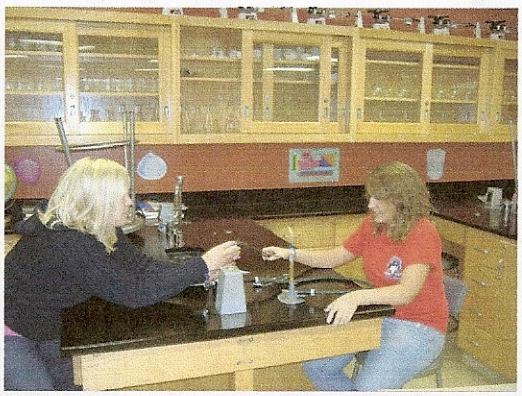
Adjustments to the Lesson Plan:

Reflections:

A Picture is Worth a Thousand Words

Science

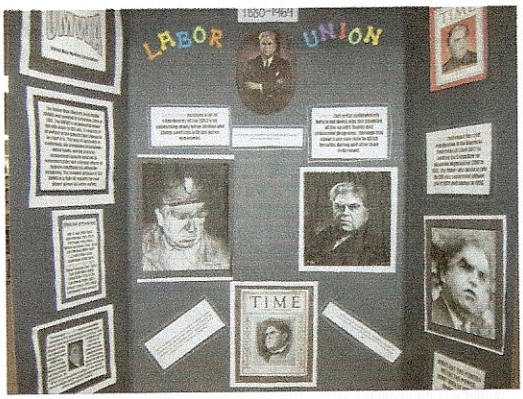
Ash content

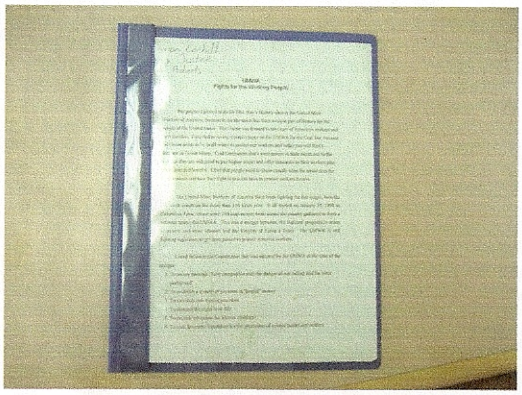


Coal Analysis

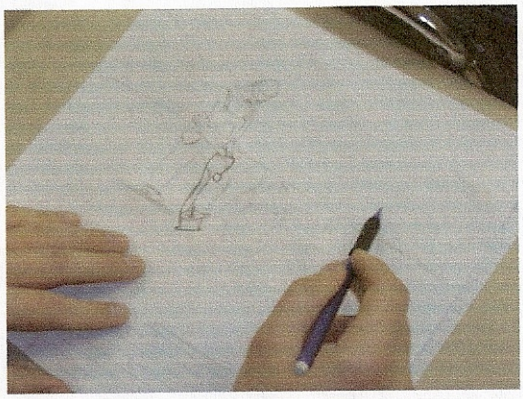
Social Studies

Working on a Social Studies paper



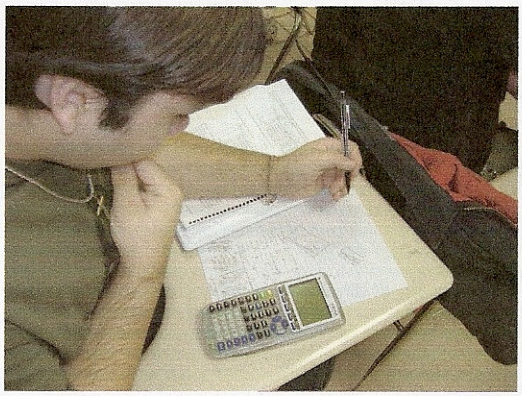


Art

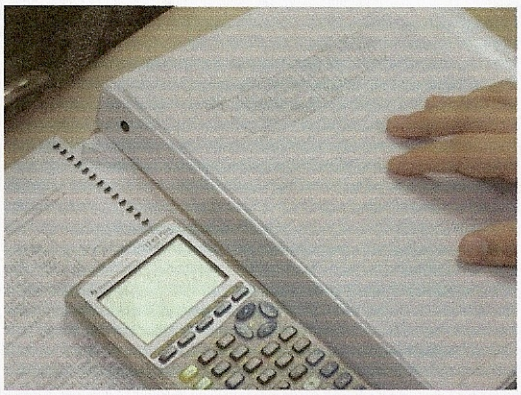


Coal drawing

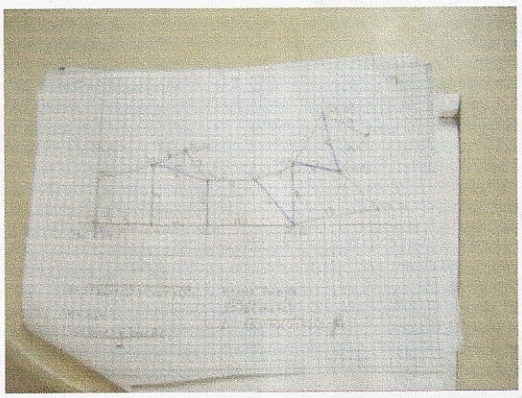
Mathematics



This math is easy!

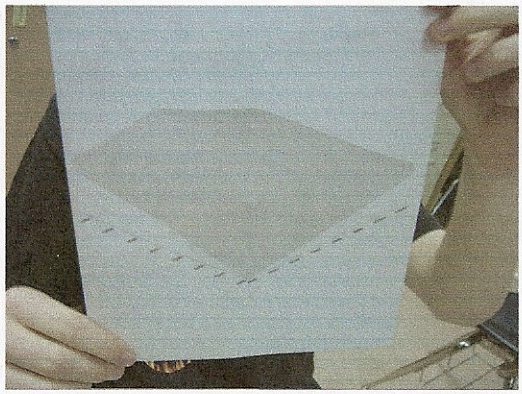


Inverse Distance to Square

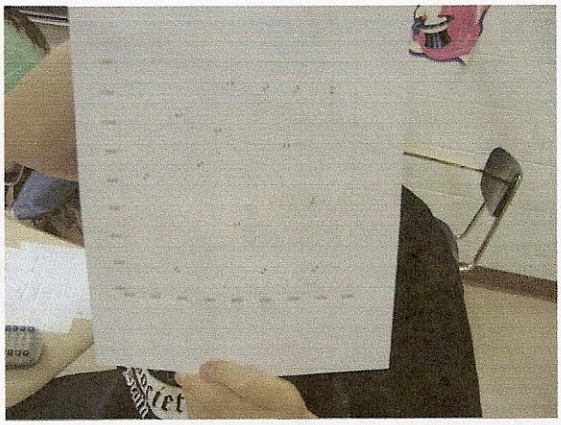


Land Track

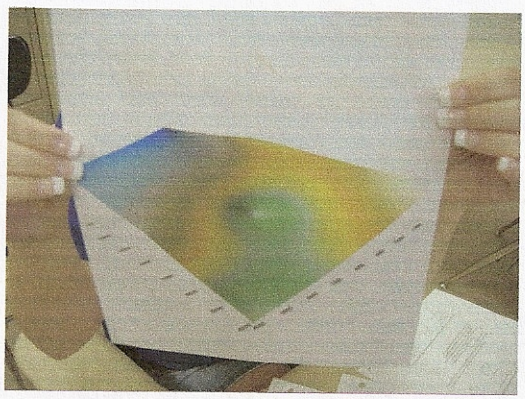
Pre-engineering



Wire frame Map

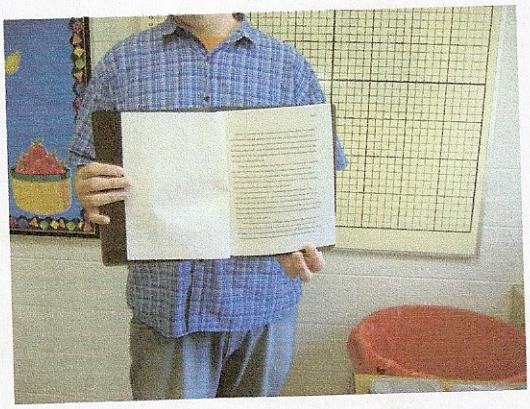


Contour Map

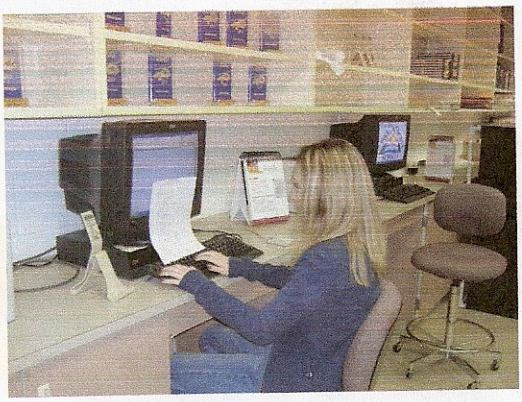


Surface Map

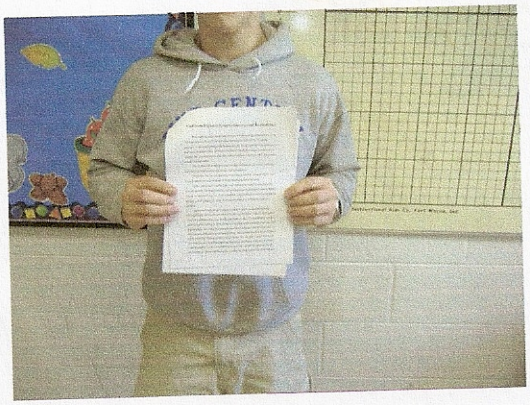
English



English paper

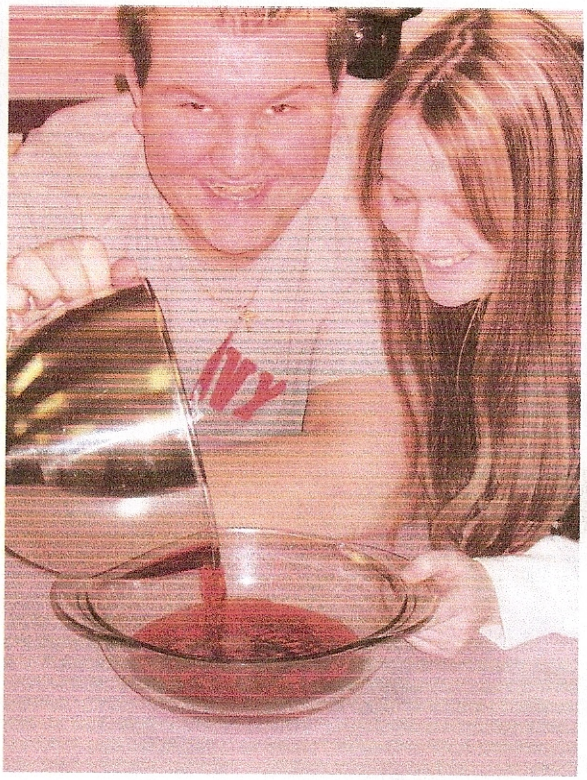


Working on an English paper

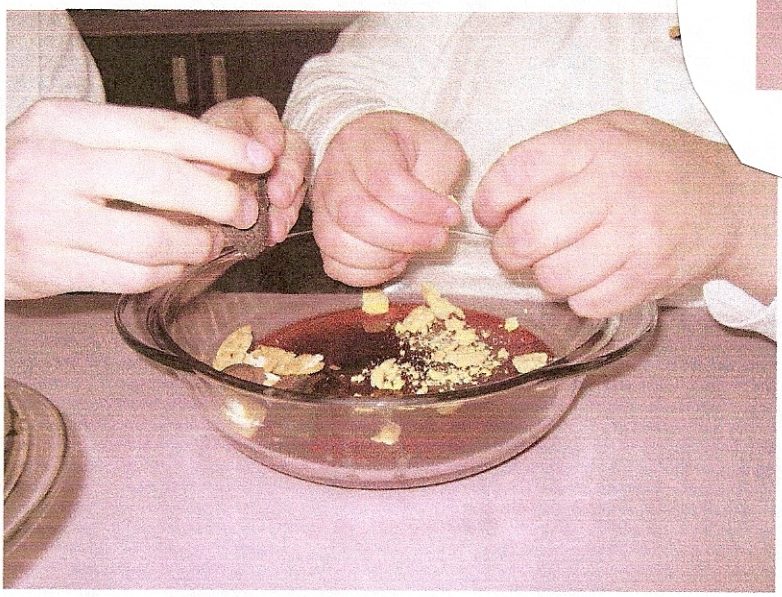


English paper

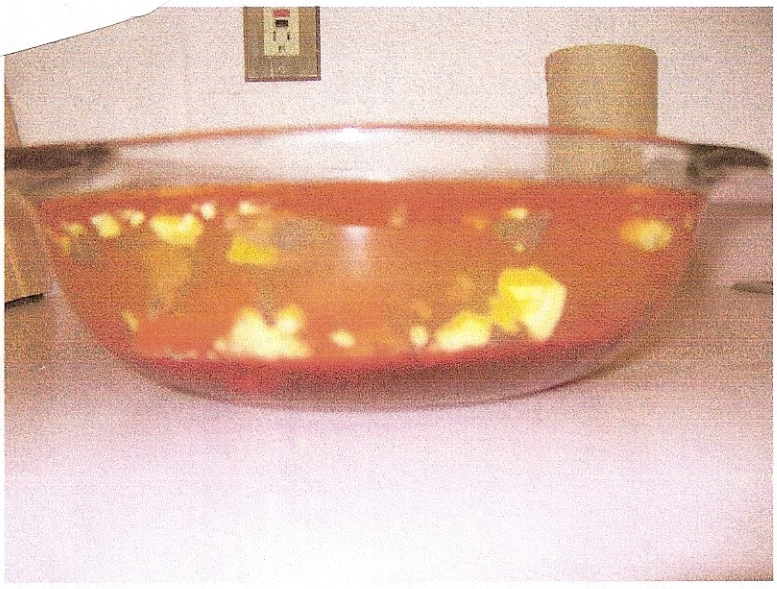
Food Services



Pouring the rock layer



Adding the Coal layer



The final product. Let's eat!