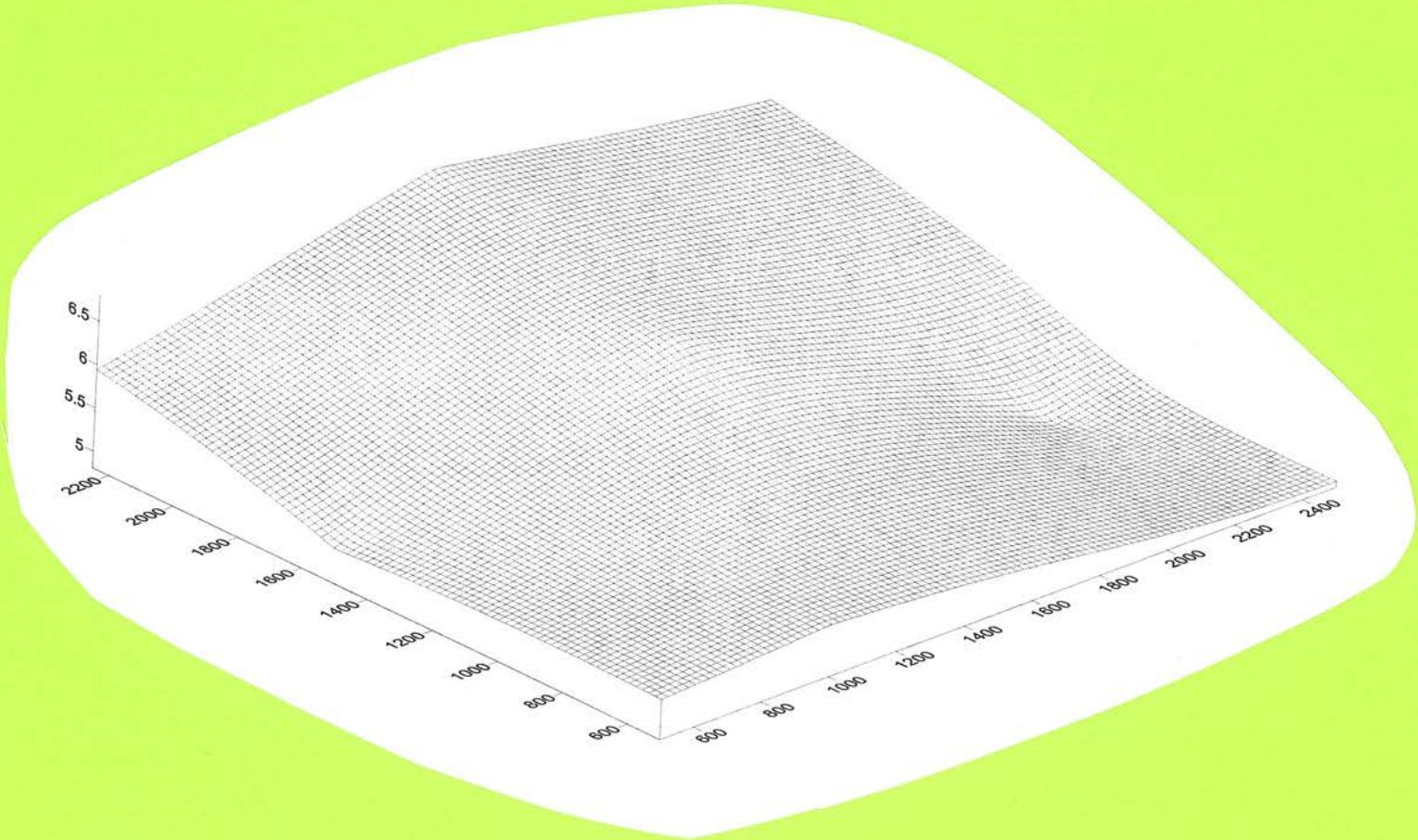
03-02-18

Ten Years in the Life of a Surface Coal Mine: Design, Production, and future Land Uses



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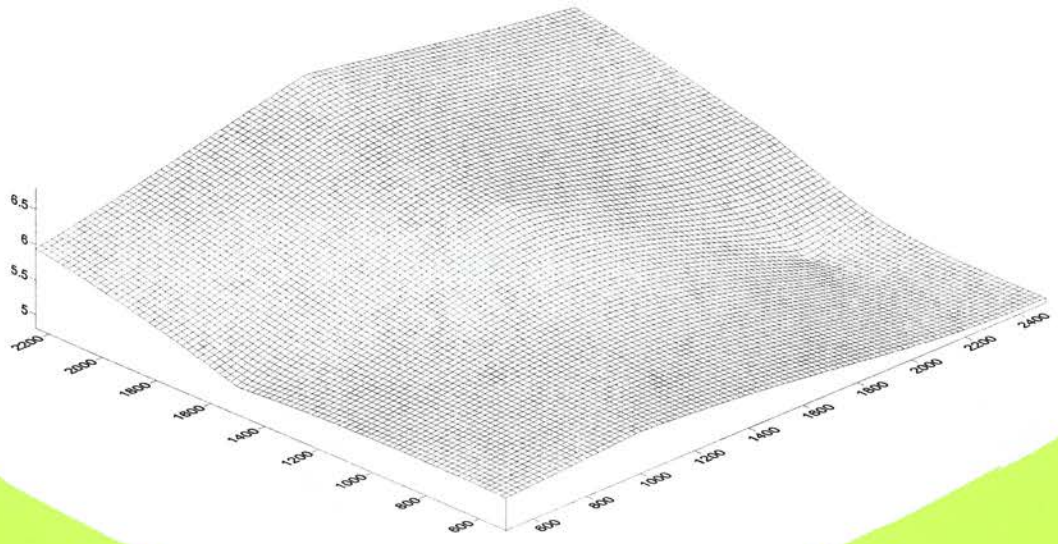

Ten Years in the Life of A Surface Coal Mine: Design, Production, and Future Land Uses

I. INTRODUCTION

My AP Calculus Students were so surprised! Several students said that it was hard to imagine! This is how my students reacted they found out that their high school was built on an "abandoned strip mine" from the 70's or 80's. When the school system made the decision to build the new high school, they had to find property that was out of the flood plain. The abandoned surface mine property at the top of the mountain, high above the flood plain, was obviously the best location to build our high school. Now, instead of providing coal to produce electricity, this property is providing level, flat land that our community is using to help educate our youth. Often, our students can look out the window of their school and observe the dear, turkey, and elk that are also making good use of this "abandoned strip mine".

My students and I were able to list several other schools, stores, prisons, golf courses, airports, and homes that were built on abandoned and reclaimed surface mine property. This discussion with my AP Calculus students about the location of our high school helped us to formulate a topic for our coal study unit. We decided that the overarching-goal for our unit would be: "Ten Years in the Life of a Surface Coal Mine: Design, Production, and Future Land Uses". This unit would be broad enough to include the participation of all interested students from every academic department in our school. It would also contain several key elements that are crucial for exploring our chosen topic to the maximum degree. First, the unit should emphasis contextual learning because, research shows, students that are engaged in hands-on project based learning are more likely to remember what they have learned. Second, the unit should challenge students to solve real world problems encountered in surface mining. They should have to think critically, use problem solving skills, and be engaged in the highest levels of Blooms taxonomy. Third, the unit should address any core content standards in each academic area.

The students in each class that were participating in our unit were asked to investigate at least one element involved in the design and operation of a surface coal mine during a 10 year

period. These included the 3 primary phases: 1. The design and preplanning phase, 2. the coal production phase, and 3. uses for the mine property after the mines closure and the land reclaimed.

Our pre-engineering students started the unit by designing the surface mine and mapping the coal seam and the surrounding rock strata. Our mathematics students then used the maps and raw data to look at several critical issues that are relevant to designing and operating a surface mine. The science, English, Food services, art, and music students finished the unit.

The unit addressed the following KACS standards:

1. **G-MG** Use geometric shapes, their measures, and their properties to describe objects
   7 Apply geometric methods to solve design problems
   (note: There are no KCAS standards specifically for differential and integral calculus
2. Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems.★
   4 Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects
3. **F-BF**1 Write a function that describes a relationship between two quantities.
   (note: There are no KCAS standards specifically for differential and integral calculus
4. **1.16** Students use computers and other kinds of technology to collect, organize, and communicate information and ideas.**3.3** Students demonstrate the ability to be adaptable and flexible through appropriate tasks or projects.**6.1** Students connect knowledge and experiences from different subject areas.**6.3** Students expand their understanding of existing knowledge by making connections with new knowledge, skills, and experiences.
5. **2.19** human actions modify the physical environment and, in turn, the physical environment limits or promotes human activities.
6. HS-PS1-1. Use the periodic table as a model to predict the relative properties of elements based on the patterns of electrons in the outermost energy level of atoms. HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling.
7. **1.14** Students make sense of ideas and communicate ideas with music.• create new, listen to, choose and perform music to fulfill a variety of specific purposes
8. **2.22** Students create works of art and make presentations to convey a point of view.• create new, choose and experience artworks created to fulfill a variety of specific purposes
9. Students will write for a variety of authentic purposes and audiences: • analyze and communicate the significance of a relationship, one's own experiences and/or the experiences of others • analyze and communicate through authentic literary forms to make meaning of the human condition.
10. **2.30** Students evaluate consumer products and services and make effective consumer decisions.
11. **6.1** Students connect knowledge and experiences from different subject areas. **6.3** Students expand their understanding of existing knowledge by making connections with new knowledge, skills, and experiences.

These are the I Can statements for our unit:

1. I can use integral calculus to estimate the volume of the overburden at the surface mine
2. I can 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. I can use the polygonal method and the height of the coal seam to accurately estimate the volume of coal in the coal seam and determine its current market value.
4. I can calculate the equation for the vertical curve of a surface mine haulage road.
5. I can determine the volume of the coal in the coal seam using the Surfer 8 contouring software.
6. I can generate at least four 2-diminsional and 3-diminsional pictures of the coal seam using the Surfer 8 contouring software
7. I can write a coal lease agreement for a surface coal mine
8. I can use scientific analysis to determine the ash, moisture, sulfur, and BTU content of the coal mined at the site.
9. I can write a song with coal as the central theme.
10. I can sing and/or perform a song about coal.
11. I can create a 2-D or 3-D work of art about coal mining
12. I can write a short story, poem, or essay about coal
13. I can illustrate a coal seam by baking a cake or pastry.
14. I can use exponentials to predict the 5^{th} year growth rate of an elk population that had been transplanted to the mine property
15. I can use logarithms to predict to the number of years until the transplanted elk herd has reached its maximum carrying capacity.
16. I can use integral calculus to estimate the total number of black bears during the 10^{th} year that will be present on the mine property from a small population of transplanted black bears.

These are the 11essential questions that were utilized in this unit:

1. How can I use Integral Calculus to calculate the volume of the overburden?
2. 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 and determine the volume and current value of the coal located at the property?
3. How can I use differential equations to calculate the "parabolic vertical curve" for the surface mine "haulage road" at the surface mine?
4. How can technology be used in the design and operation of surface mines?
5. What is the procedure used in writing a coal lease agreement?
6. How do you determine the ash, moisture, sulfur, and BTU content of the coal mined at the site?
7. How do you write a song about coal mining?
8. How is coal used in as a theme in different types of art?
9. How do you write a short story, poem, or essay about coal?
10. How can I illustrate a coal seam by baking a cake or pastry?
11. How can abandoned surface mine property be used to improve the quality of life for people in the surrounding area?

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 surface mine preplanning and reclamation 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 worked in groups of 3 or 4 and used a gravity protractor to determine the slope distance and angle of elevation to the top of the high wall behind our school. They then used this data to calculate the ratio of the volume of the overburden to the volume of coal at the site. Other math students worked cooperatively in groups of 3 or 4 to use the polygonal method to determine the amount and value of coal located on the land track by using core drilling data. These students 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 geostatistical techniques. Methods that were employed to predict the height of coal were the inverse distance method, triangulation, and Delauney Triangulation. They 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.

Some students worked in groups of 3 or 4 to investigate uses for our surface mine property up to 10 years after the mine has closed. They developed and wrote a problem that would model the population growth, over the 10 year period, of a deer herd and a group of black bears that would be transplanted onto the abandoned mine property. They also used this model to predict the number of years until the transplanted deer herd and the black bear population would reach their maximum carrying capacities.

B. Science

Our chemistry students worked in groups of 4 and performed coal analysis on the coal found at our mine site. This included tests for ash content, moisture, BTU, and calorific values.

C. Pre-Engineering

Students enrolled in our pre-engineering curriculum worked in groups of 3 or 4 and used techniques of integral calculus to calculate the volume of the overburden at our surface mine. Other students worked in groups of 3 or 4 to design and write the parabolic equation for a coal haulage road to our mine. These students worked cooperatively within their groups to use the Surfer 8 contouring and 3-D mapping software to estimate the volume of coal on the land track. They used the 'inverse distance to a square" functions of the Surfer 8 software to draw 2-dimensional and 3-dimensional maps of the coal seam. They used the Surfer 8 software to design surface mine with at least to levels. The Surfer 8 function was also used to predict the height of the coal seam at the location of the gas well.

D. English

These students wrote short stories and portfolio papers with coal as the central theme.

E. Social Studies

Students enrolled in Political science classes conducted research on the history of surface mining in Kentucky. They also researched how to write a 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.

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 was an excellent unit. The students and teachers that participated in the unit have a better understanding of the potential benefits of surface mining to our local community. We realize how much surface mines help to support the local economy by providing good paying jobs. We know that surface mining helps to provide Kentucky with cheap electricity and, after participating in this unit, we understand that by making flat usable land available for residential and commercial development a surface coalmine can continue to benefit the local community for generations to come. Today's abandoned strip mine back on the mountain could one day, even decades later, provide the level property needed to build an airport, industrial park, or school.

This year's coal study unit was a resounding success. It met or exceeded all three criteria mentioned in the introduction. It involved the active participation of eighteen teachers, one administrator, and 362 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 others 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 KACS Standards, taught students the high school core content, and helped to prepare our students to be successful in college, the military, or the workforce. It was apparent to all participants that this unit met all the expectations that we had originally set for the unit.

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 success because the goal set for the unit was achieved. The 11 essential questions were answered either partially or in full. 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.

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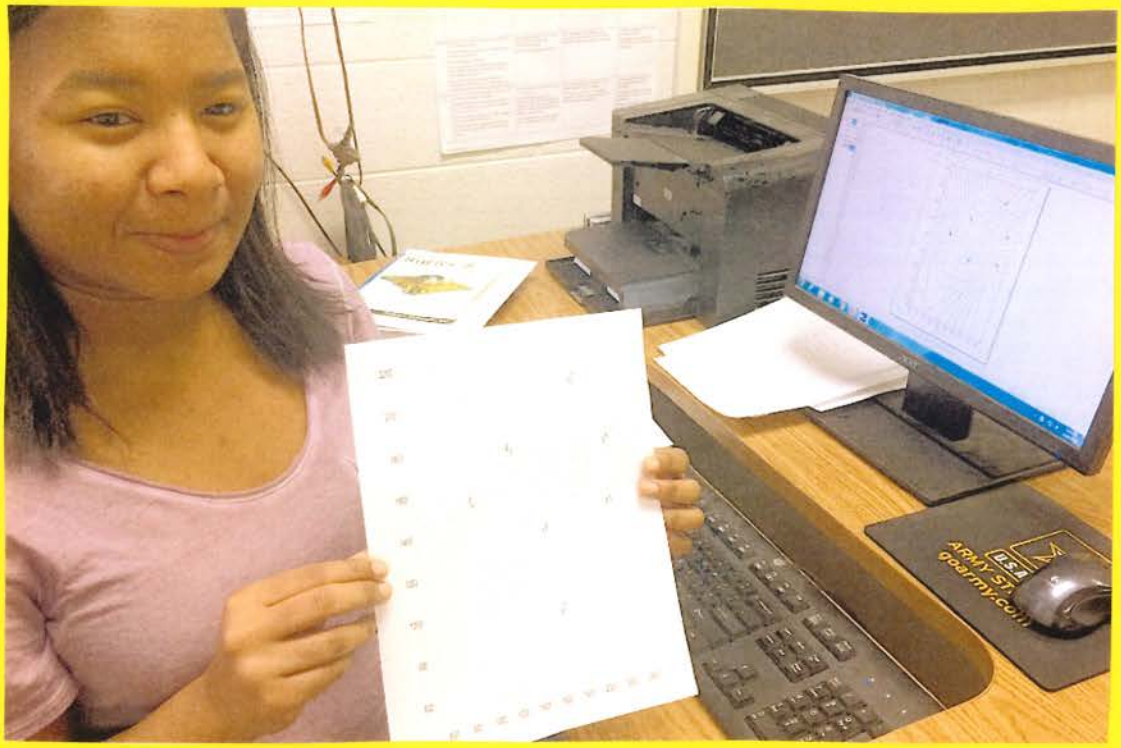
Pictures



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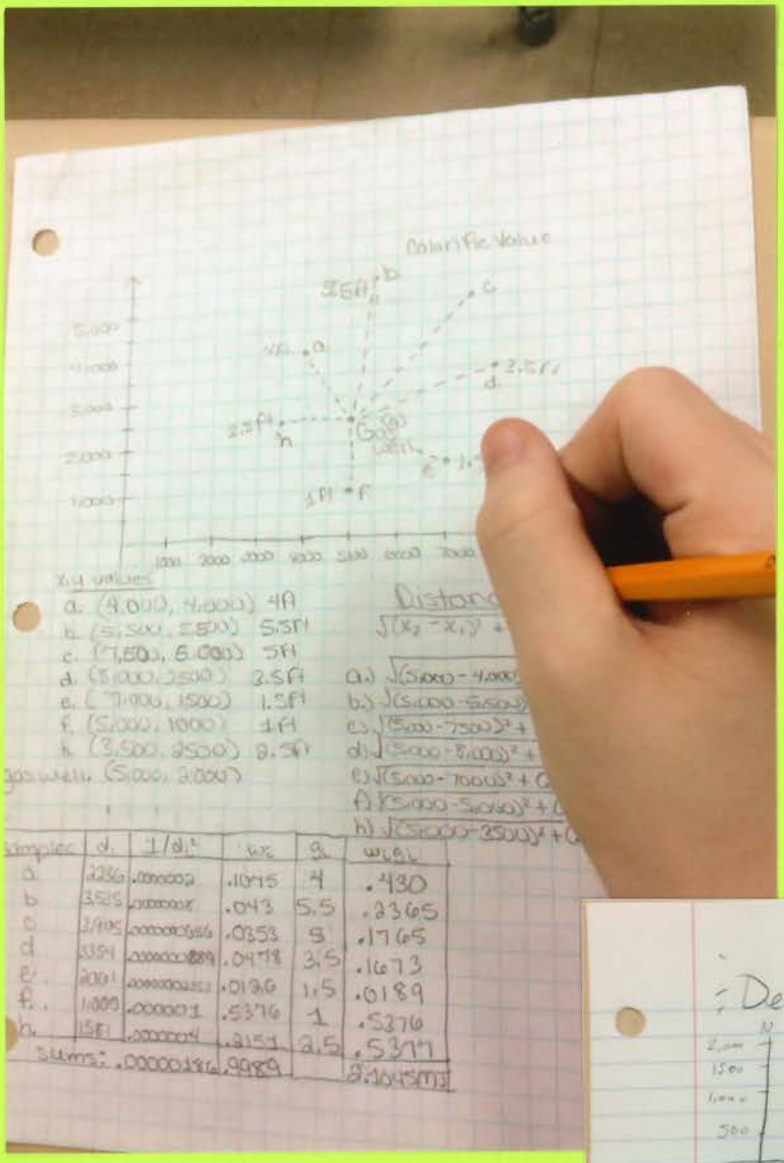
Mathematics



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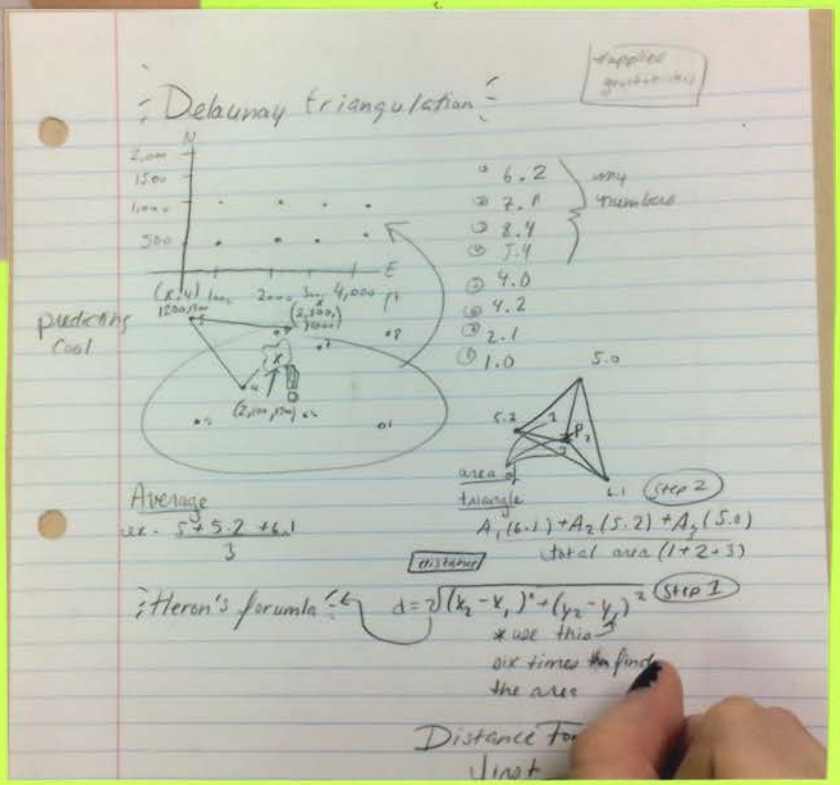

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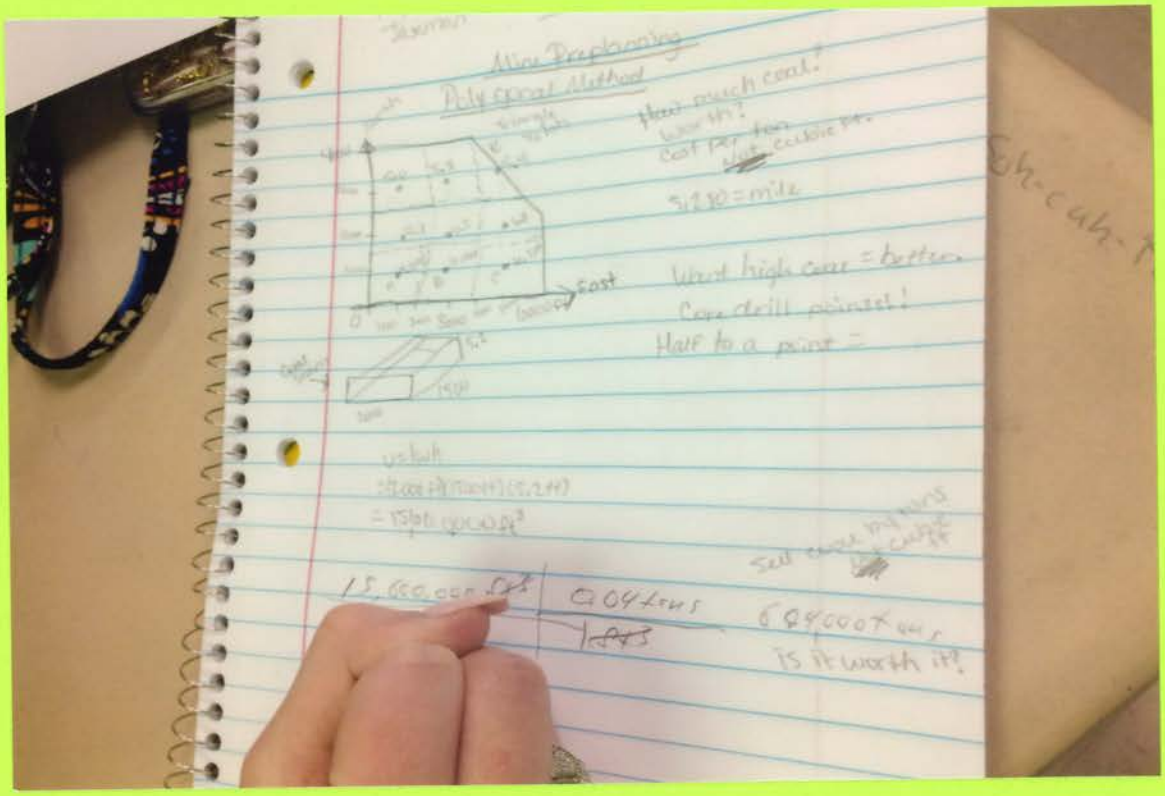

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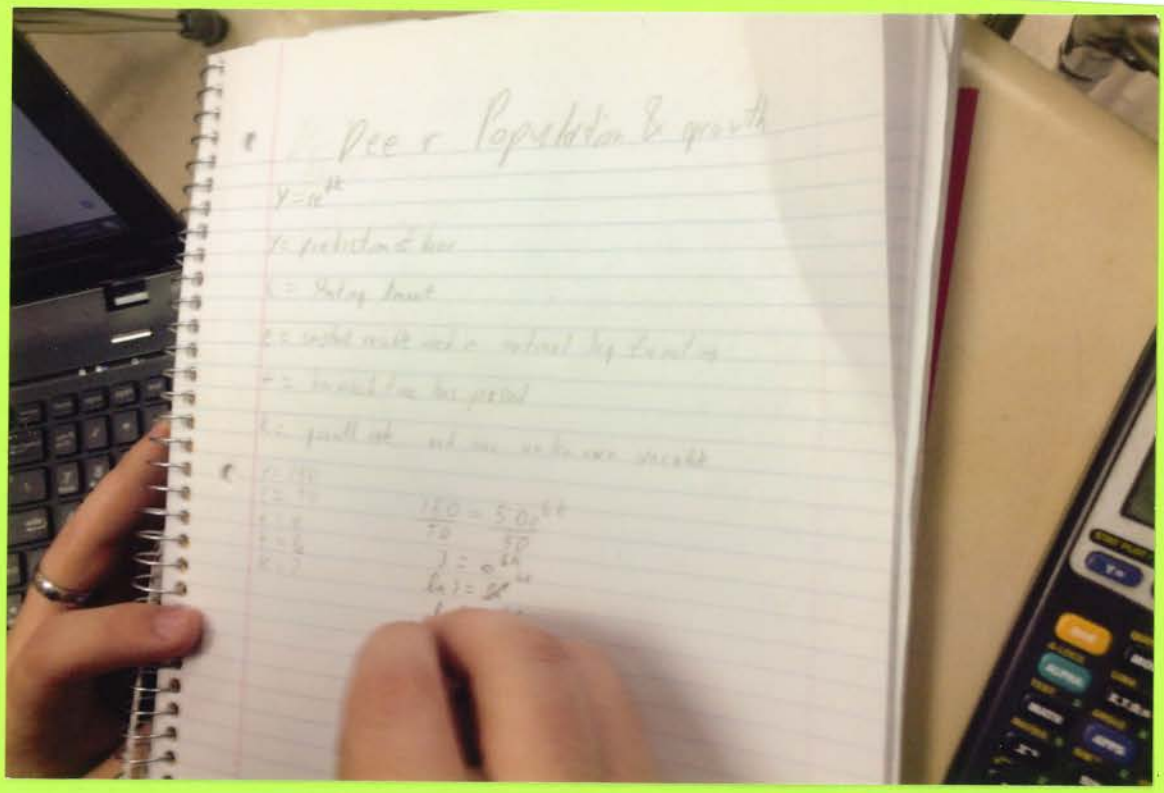

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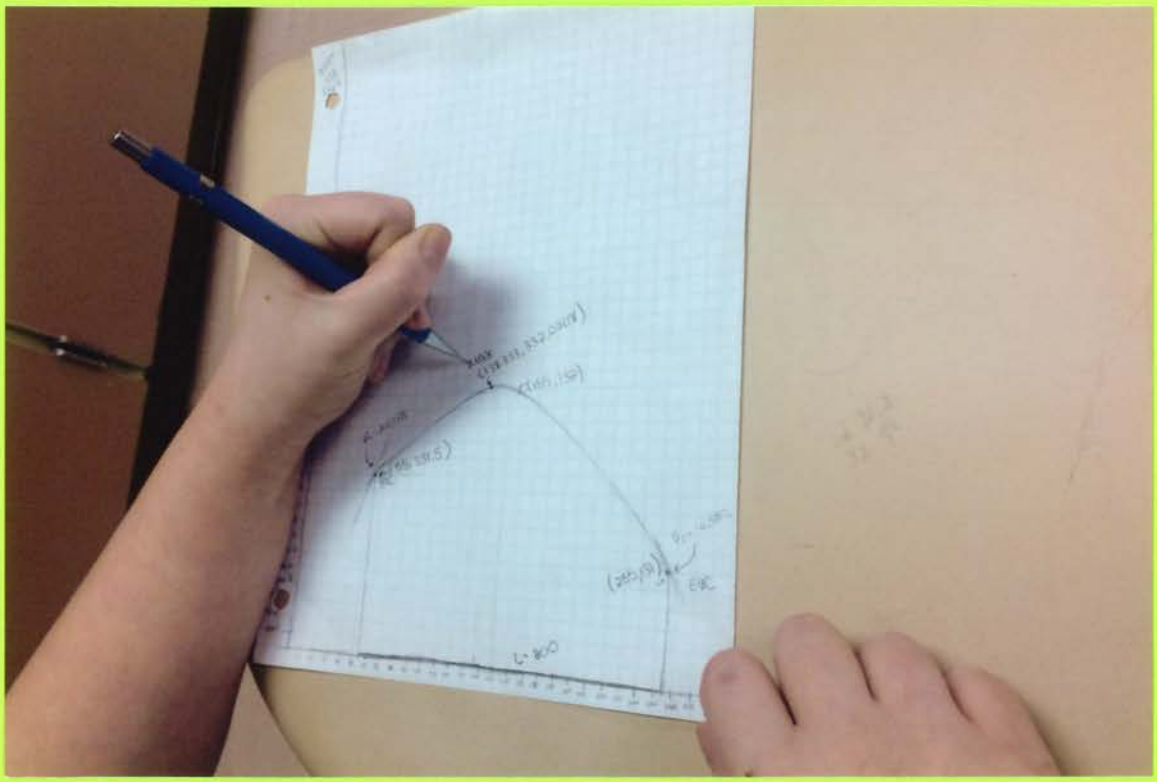
Pre-engineering



I can calculate the equation for the vertical curve of a surface mine haulage road.

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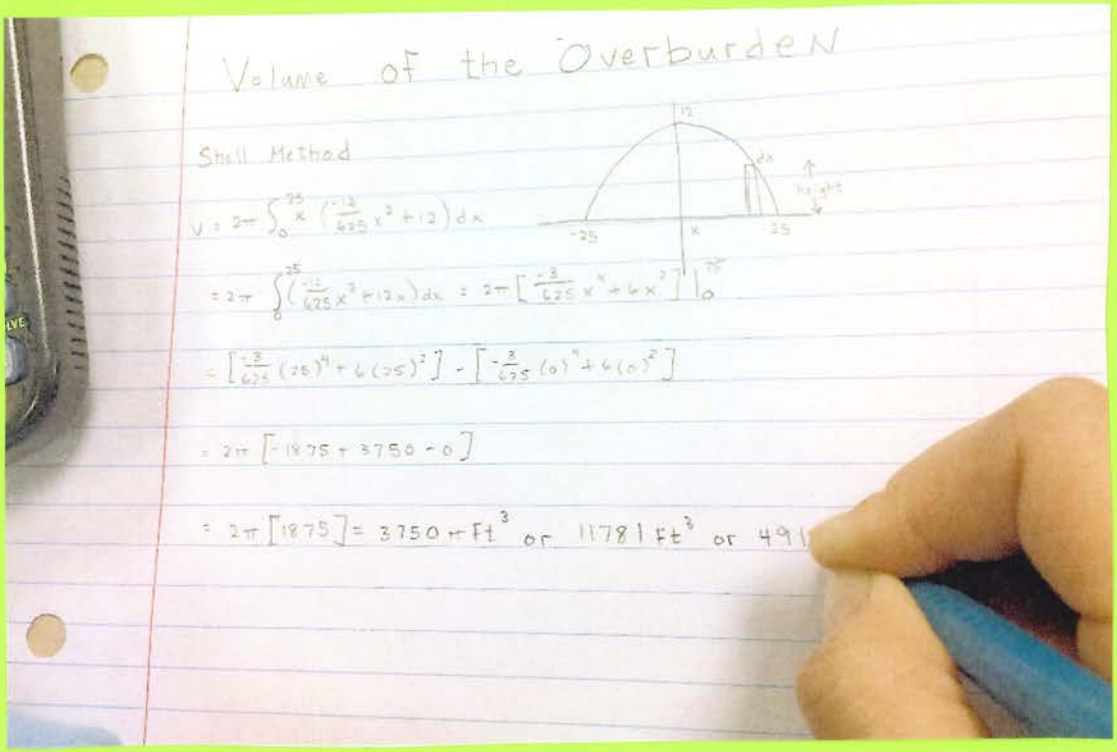

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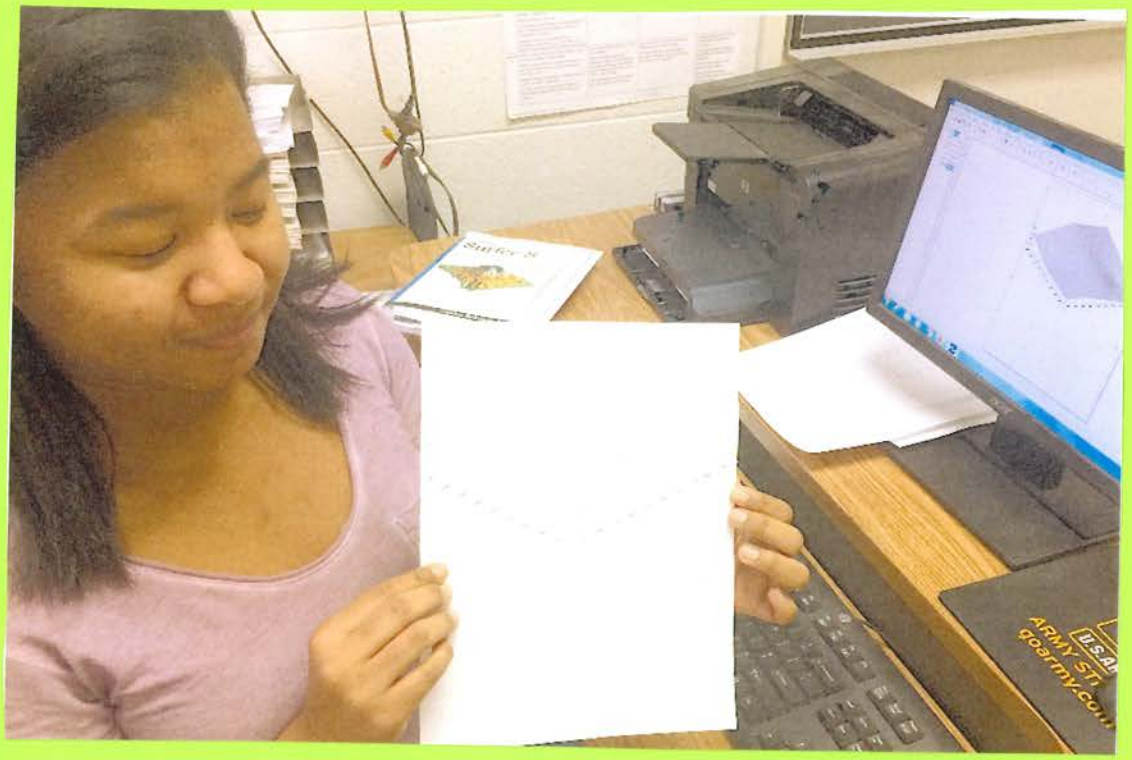

I can generate at least four 2-diminsional and 3-diminsional pictures of the coal seam using the Surfer 8 contouring software

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Science

I can use scientific analysis to determine the ash, moisture, sulfur, and BTU content of the coal mined at the site

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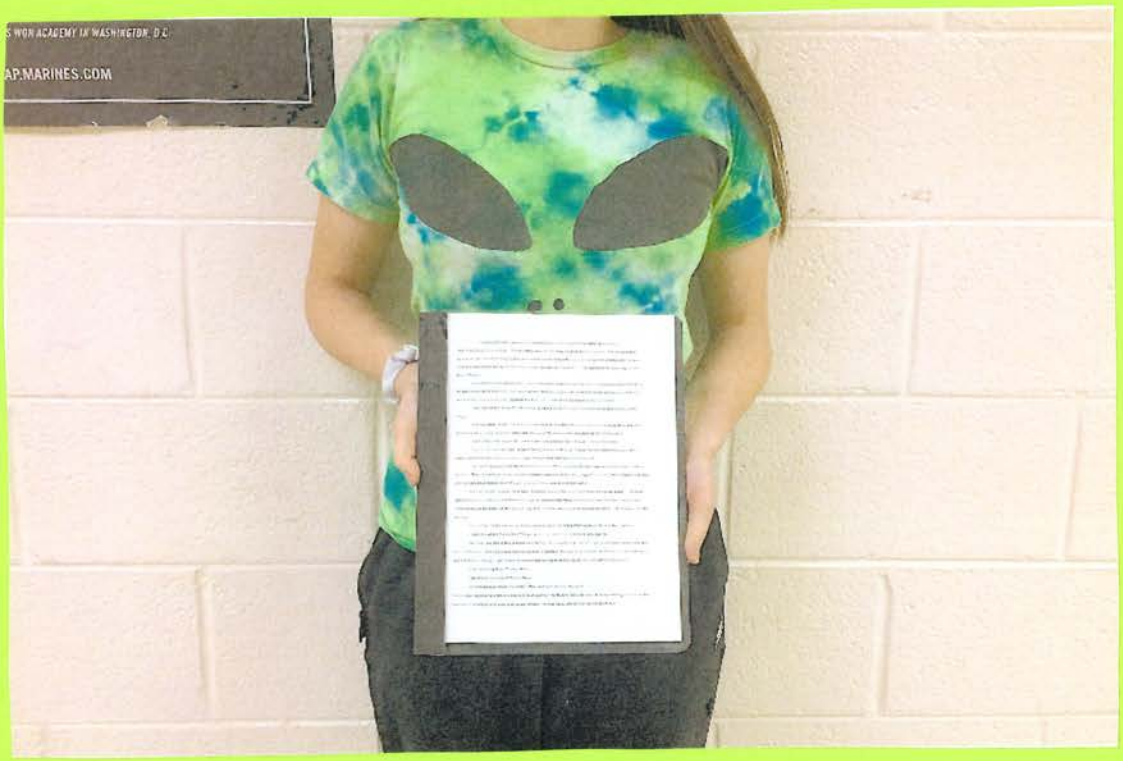
English



I can write a short story, poem, or essay about coal

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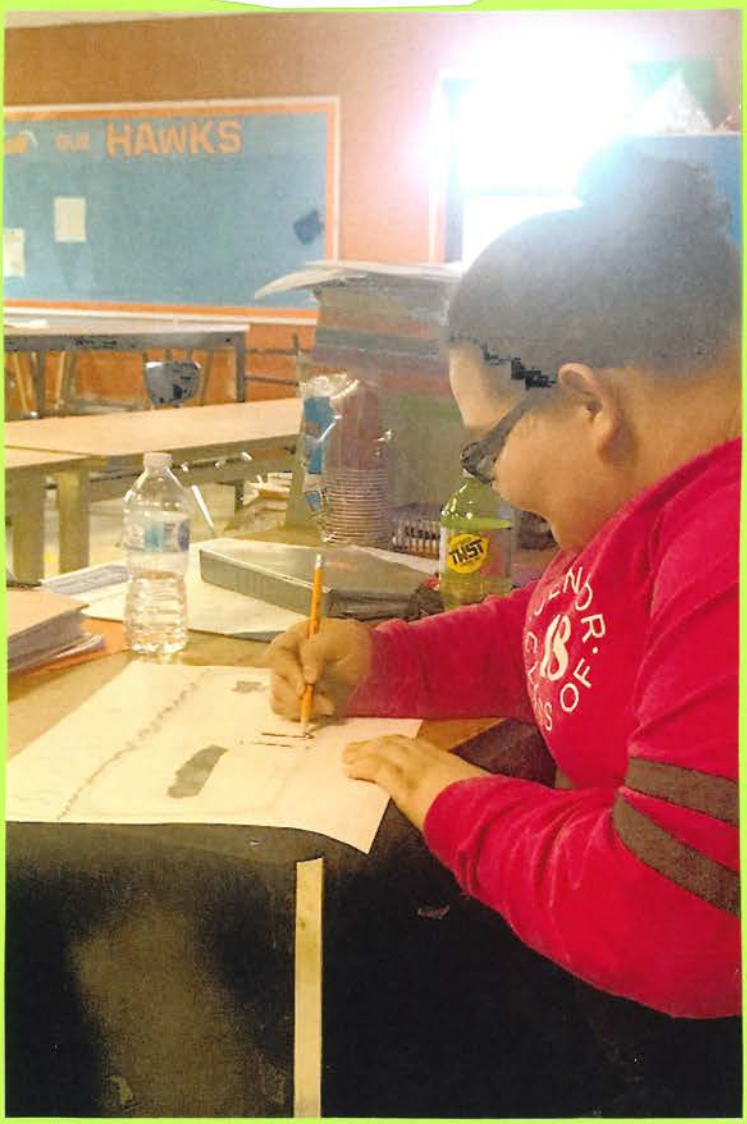
Art



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Social Studies

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Music

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I can sing and/or perform a song about coal

Food Science

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