Standard 1—Analysis, Inquiry, and Design

Elementary

Mathematical Analysis

Context

Math 4/5 Pilot test Spring 1995

Performance Indicators

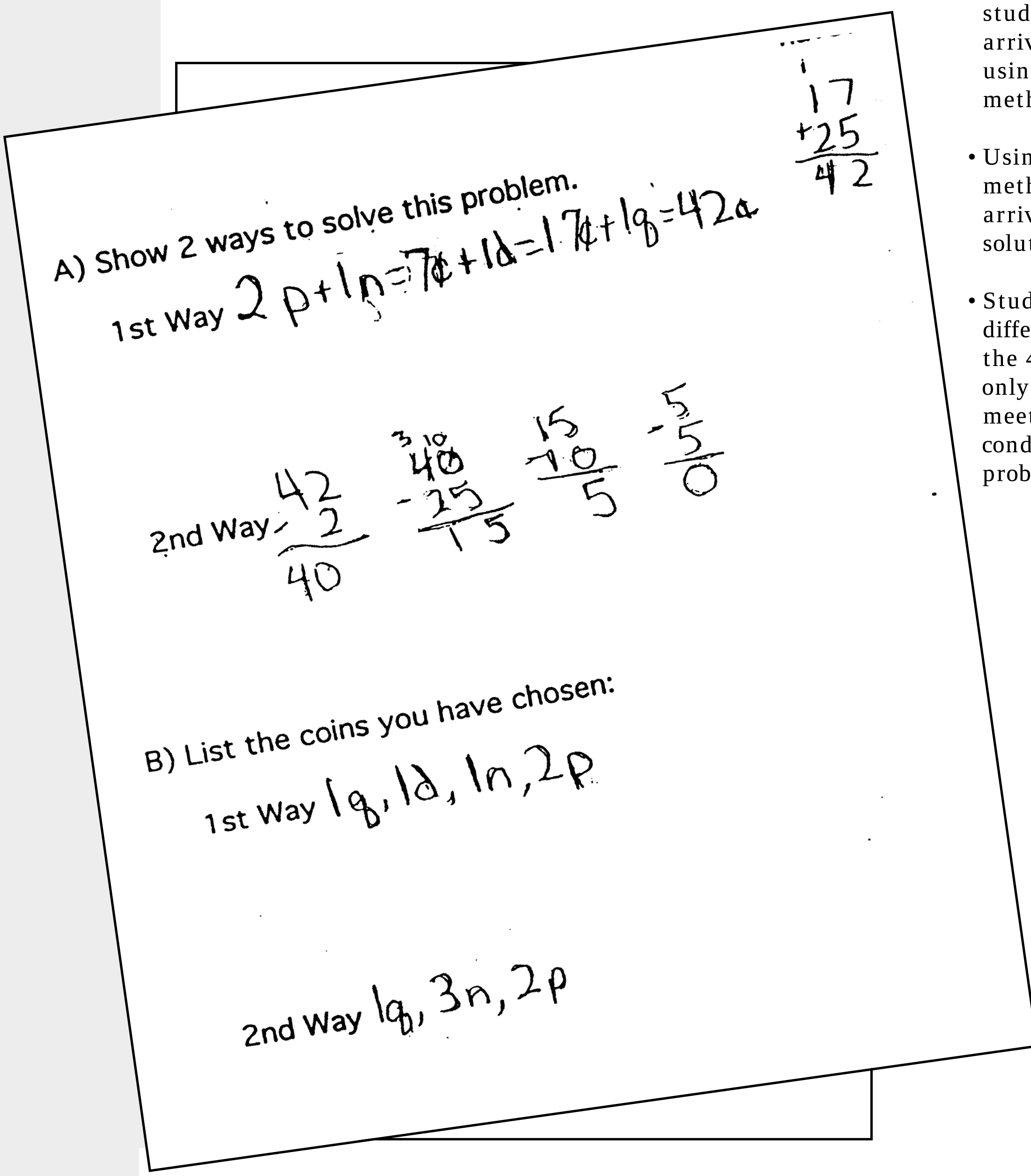
Students can:

. . . explore and solve problems generated from school, home, and community situations using concrete objects or manipulative materials when possible.

Student Work Sample

Task

I have 6 coins worth 42 cents. What coins could I possibly have? Draw a picture of the 6 coins which total 42 cents.



A) Show 2 ways to solve this problem.

1st Way 2p+1n=7¢+1d=17¢+1q=42¢

17
+25
42

2nd Way 42 − 2 = 40; 40 − 25 = 15; 15 − 10 = 5; 5 − 5 = 0

B) List the coins you have chosen:

1st Way 1q, 1d, 1n, 2p

2nd Way 1q, 3n, 2p

Commentary

The Sample:

- The symbolic equation clearly illustrates the thinking of the student as he/she arrives at a solution using an addition method.
- Using a subtraction method the student arrives at a second solution.
- Student shows two different solutions to the 42 cent sum, but only the 2nd way meets both conditions of the problem.

Standard 1—Analysis, Inquiry, and Design

Commencement

Mathematical Analysis

Context

Course I Regents Examination, June 1995.

Performance Indicators

Students can:

. . . apply algebraic and geometric concepts and skills to the solution of problems.

Student Work Sample

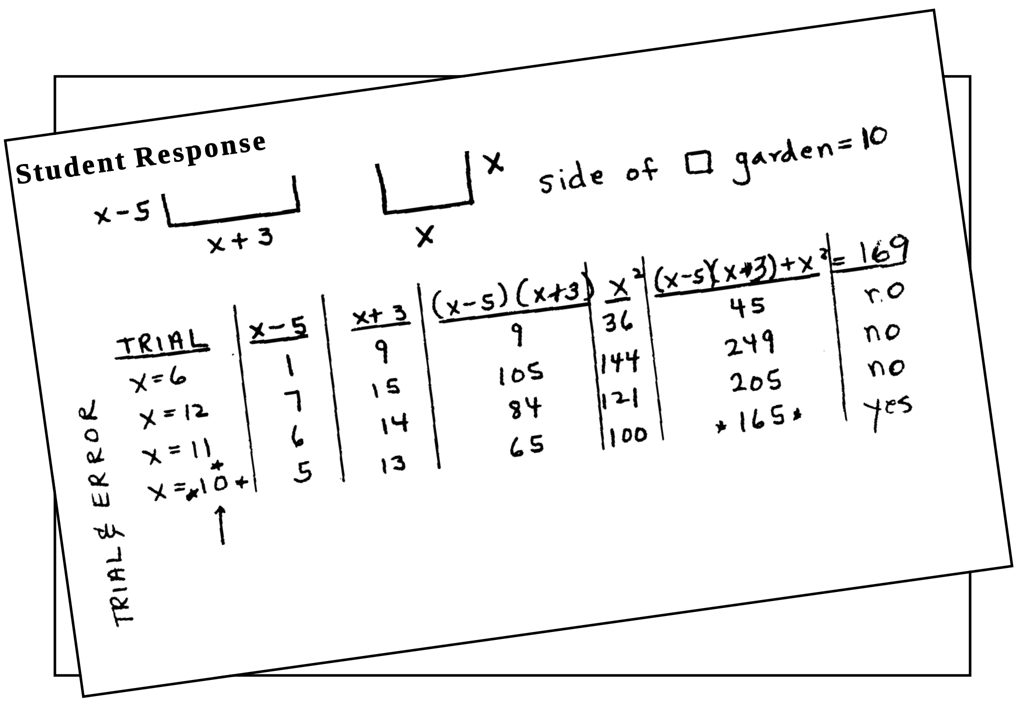
Task

A landscaper has two gardens: one is a square and the other is a rectangle. The width of the rectangular garden is 5 yards less than a side of the square one, and the length of the rectangular garden is 5 yards less than a side of the square one, and the length of the rectangular garden is 3 yards more than a side of the square garden. If the sum of the areas of both gardens is 165 square yards, find the measure of a side of the square garden. Show or explain the procedure used to obtain your answer.

Commentary

The Sample:

- Student accurately illustrates, labels, and represents information and relationships in the problem.
- Student prepares and labels chart to test trial and error hypotheses.
- Student makes, evaluates, and adjusts conjectures against conditions of the problem.
- Student recognizes and accepts proper solution.



Elementary

Scientific Inquiry

Student Work Sample

Context

In this fourth-grade activity students were designing a slide to be used in a proposed playground for kindergarten children. Student designers were to take into account safety features, cost factors, design of the playground, and fun for the children who would ultimately use the slide.

Performance Indicators

Students can:

. . . develop written plans for exploring a phenomena. . . .

. . . carry out their plans through direct observation and through . . . measurements of quantities.

. . . organize observations and measurements . . . .

. . . interpret observations and measurements, recognizing simple . . . relationships.

Commentary

The Sample:

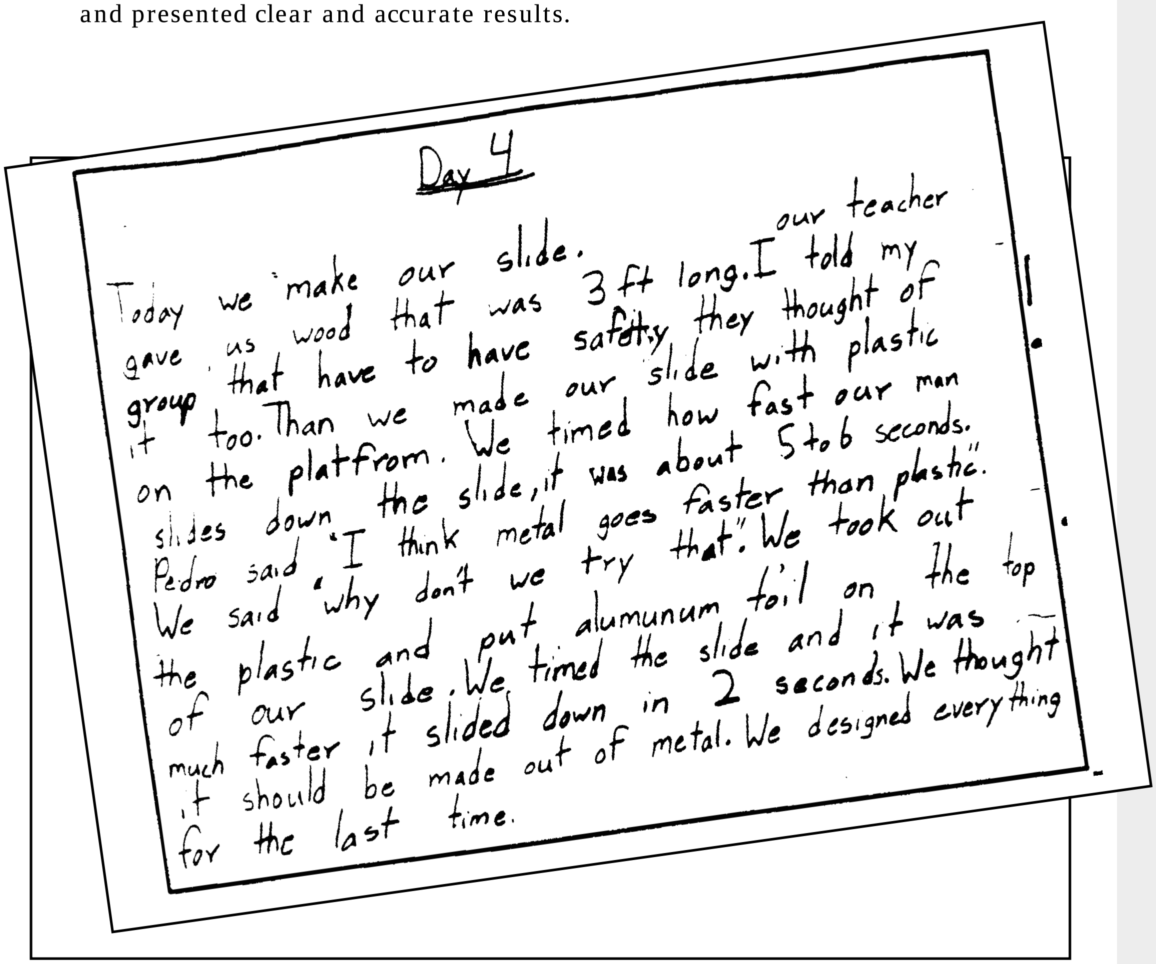
- Shows that students raised a relevant question (Which material will make the sliding faster?).
- Shows that students designed and performed a simple experiment (compared the sliding time on a plastic and metal model).
- Shows that students collected data (time in seconds).
- Shows that students arrived at an appropriate conclusion (to be fast, the slide should be covered with metal).
- Shows advanced progress toward understanding the use of scientific inquiry, though the work can be improved by repeating the experiment and averaging measurements, calculating speed, and presenting results in a chart form.

Scoring Guide

Scientific inquiry

• Student explored task-related science concepts and principles through appropriate experimentation.

• Student collected and analyzed data, and presented clear and accurate results.



Day 4

Today we make our slide. our teacher gave us wood that was 3 ft long. I told my group that have to have safety. they thought of it too. Than we made our slide with plastic on the platfrom. We timed how fast our man slides down the slide, it was about 5 to 6 seconds. Pedro said "I think metal goes faster than plastic". We said "why don't we try that". We took out the plastic and put alumunum foil on the top of our slide. We timed the slide and it was much faster it slided down in 2 seconds. We thought it should be made out of metal. We designed everything for the last time.

Intermediate

Scientific Inquiry

Student Work Sample

Context

An eighth grade student saw that there were a number of leaky water faucets in his school. Worried about pollution and wasting natural resources, he measured the water loss over a two-minute period, did the calculations, and found that over the year, 453,600 gallons of water would be wasted. He decided to do a study of 10 faucets in 7 neighborhood schools to determine the magnitude of the waste.

Performance Indicators

Students can:

. . . use conventional techniques and those of their own design to make further observations guided by a need for more information.

. . . Carry out their research proposals, recording observations and measurements.

. . . design charts, tables, graphs, and other representations of observations in conventional and creative ways to help them address their research questions or hypothesis.

. . . modify their personal understanding of the phenomena based on evaluation of their hypothesis.

My hypothesis was inconclusive. Only four out of the seven schools that I tested leaked over two hundred milliliters per minute. If I were to repeat this project I would test more schools and more faucets in each school.

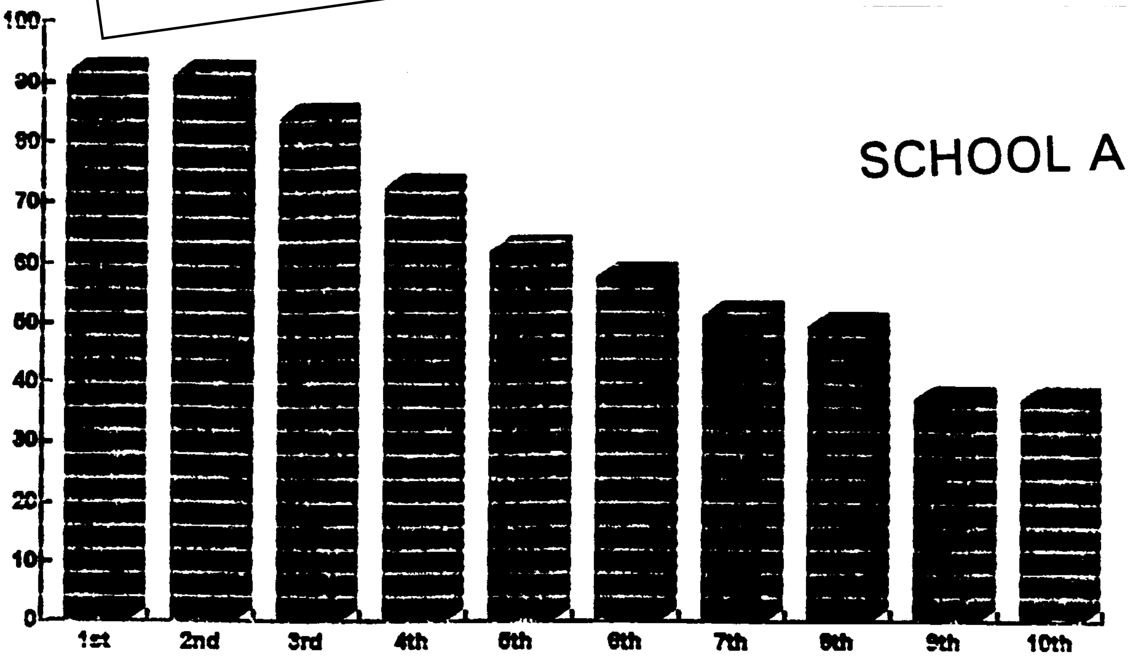
I also observed that screw top faucets leaked much more than the push button. In the future I would test whether there really is a difference between the screw top and push button faucets. This project is a very important project, because by knowing this we can find a way to fix the faucets and be able too conserve water.

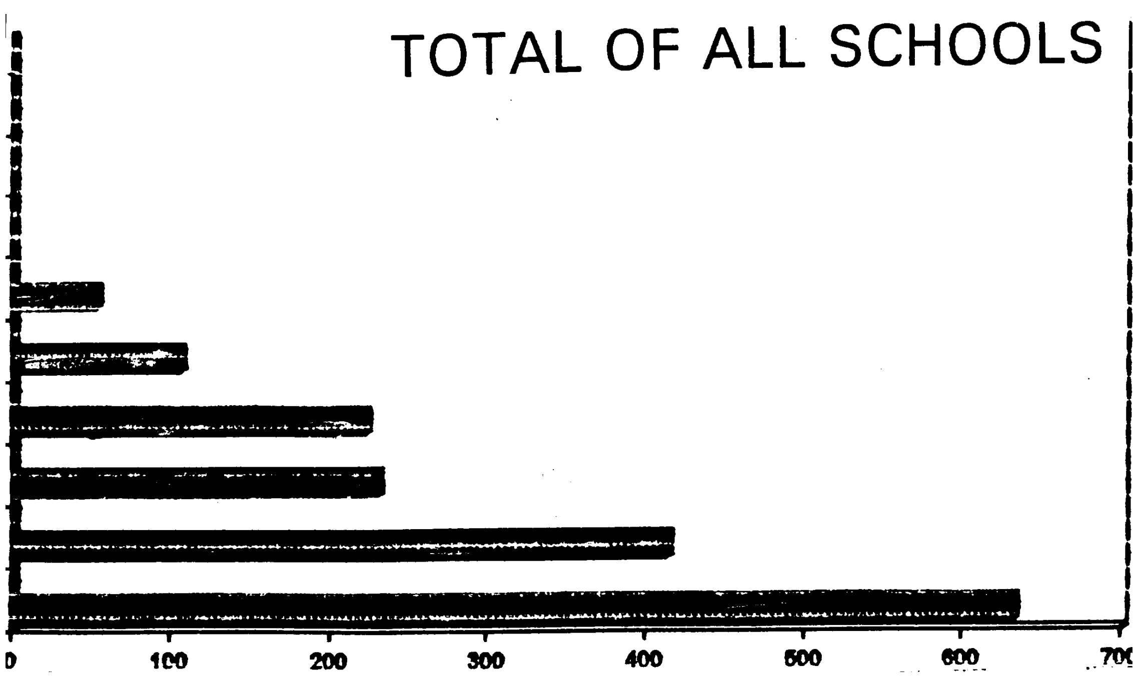
Commentary

The Sample:

- Indicates collection and manipulation of quantitative data.
- Shows a graphic display of results.
- Elaborates on other variables which may become important during further study.
- Indicates the ability to apply information generated by the study.

The graph indicates that school A leaks 219.4 ml. per minute more than the nearest school, school B. School A leaked 631.7 ml. per minute, and school B leaked 412.3 ml. per minute. School C leaked 229.4 ml per minute. School D leaked 221.9 ml per minute. School E leaked 105 ml per minute. School F leaked 53 ml per minute. School G didn't leak at all. School A-D and School G are private parochial schools. Schools E and F are public schools. Schools G and F were both high schools, and the rest of the school were elementary schools.





Commencement

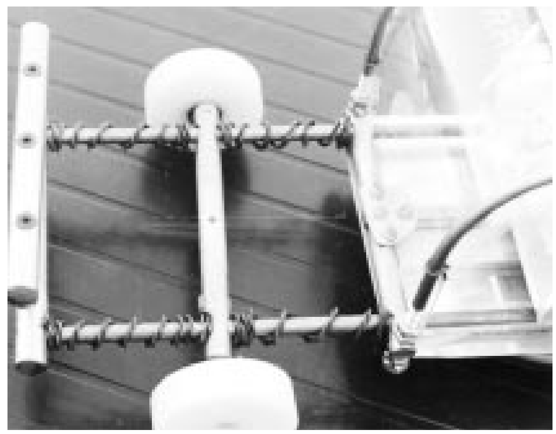
Technological Design

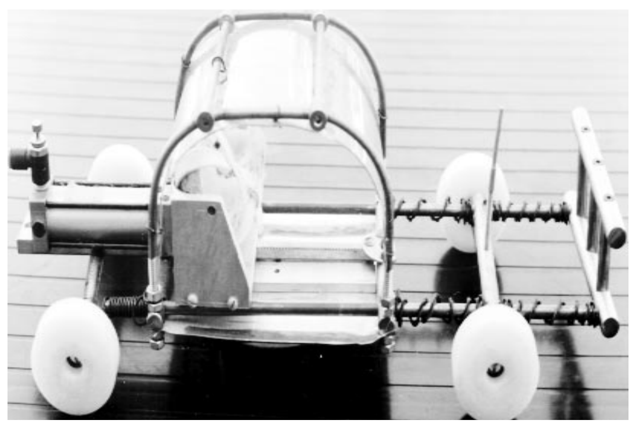
Student Work Sample

Context

This example reflects an auto safety problem posed to a 12th grade technology education Principles of Engineering class. The engineering design challenge was to design a passenger protection system for a vehicle that would carry two eggs, roll down a ramp, and crash into a berrier. An indicator was to be incorporated into the design to determine the amount of impact distance so that the crash zone could be measured accurately.

Performance Indicators and Commentary





Students initiate and carry out a thorough investigation of an unfamiliar situation and identify needs and opportunities for technological invention or innovation.

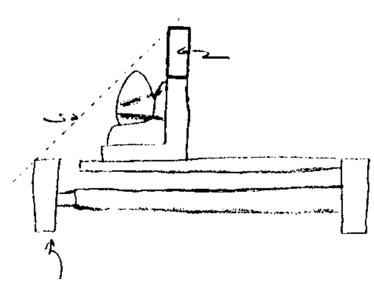
- Students investigated forces on real cars. They found initial and final velocities, deceleration, and g-forces acting on their model car after it hits the abutment.

Students identify, locate, and use a wide range of information resources including subject experts, library references, magazines, videotapes, films, electronic databases and on-line services, and discuss and document through notes and sketches how findings relate to the problem.

- Students did a great deal of mathematical modeling to obtain data which influenced their design.

Students generate a number of creative solution ideas, explore possible refinements of significant functional elements, and use mathematical and functional modeling techniques to predict possible outcomes; choose the optimal solution to the problem, assessing ideas against design criteria and constraints; explain how economics, ergonomics, and environmental considerations have influenced the solution.

- Many variations were attempted. Students sketched subsystems of the vehicle and analyzed the pros and cons of individual functional elements. They used a computer aided design package to draw components of their model. A great deal of sophisticated mathematical modeling was incorporated to both predict how the design would work, and to analyze its operation.

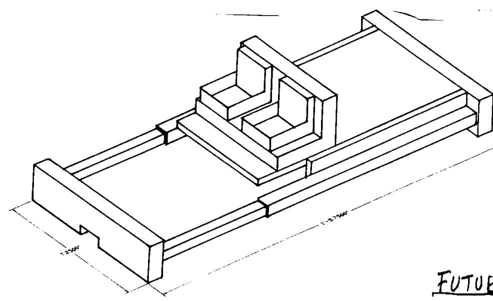


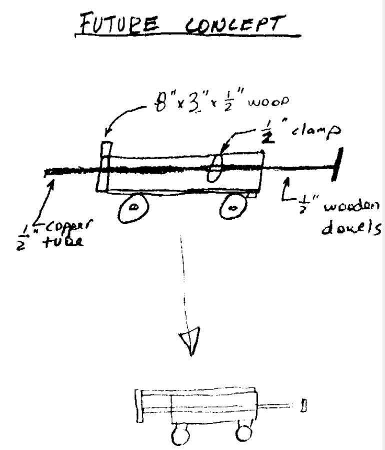
Students develop work schedules and working plans which include optimal use and cost of materials, processes, time, and expertise; accurately construct a model of the solution, incorporating developmental modifications while working to a high degree of quality craftsmanship).

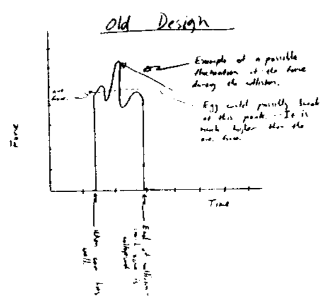
- A beautifully crafted working model of the vehicle was built. Testing along the way provided data which influenced design changes.

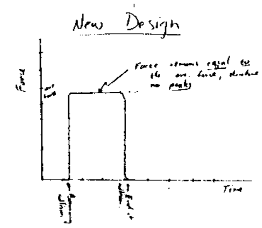
Students devise a test of the solution relative to the design criteria, and perform the test; record, portray, and evaluate performance test results through quantitative, graphic, and verbal means; use verbal and graphic techniques to effectively and persuasively present conclusions, predict impacts and new problems, and suggest and pursue modifications.

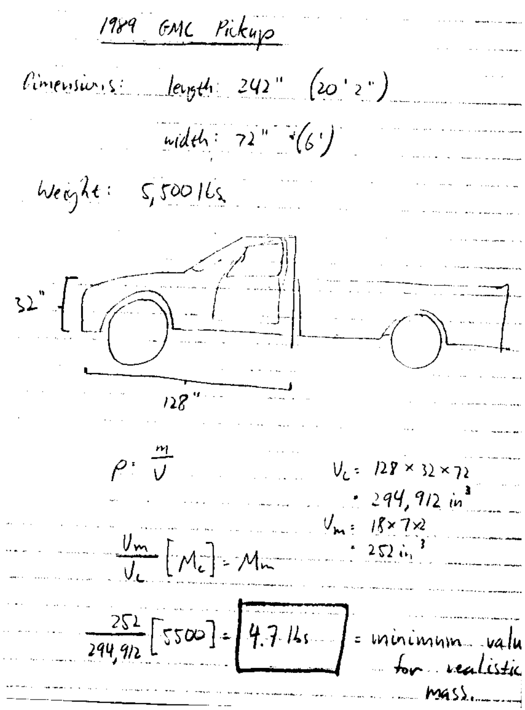
- Testing procedures were well documented and communicated graphically and orally. The degree to which the tests were successful were quantified and recorded.

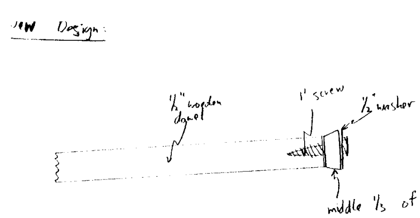












Standard 1—Analysis, Inquiry, and Design

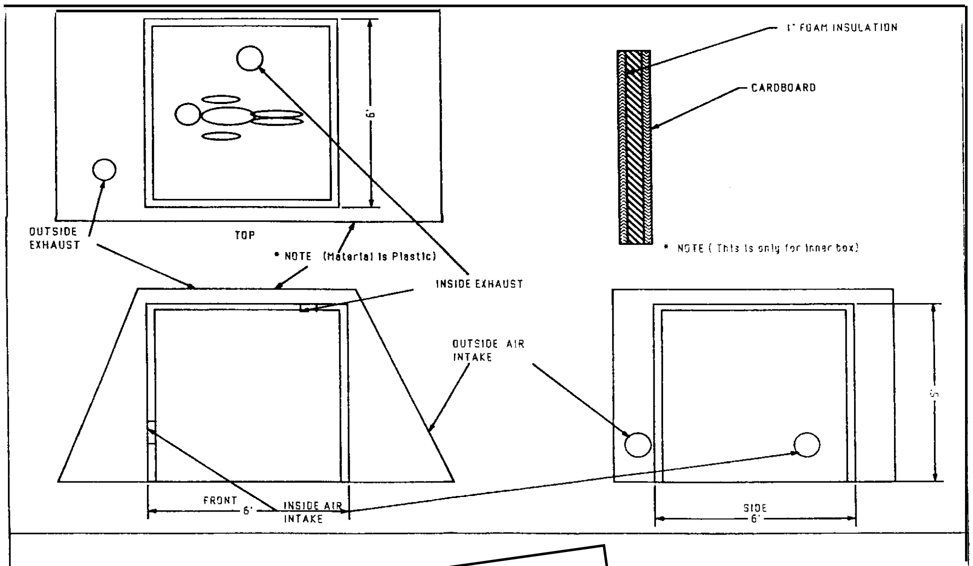
Commencement

Technological Design

Context

11th grade technology education students were asked to design an emergency shelter that could be air dropped to survivors of an airplane crash in a cold, snow covered environment. The shelter must be carried by one person, withstand a parachute drop, and be heated by the body heat of four survivors to 50o F when the outside temperature is 20o F. The shelter would be accompanied by pictorial assembly instructions as the survivors might not be English-speaking.

Student Work Sample



The first thing we had to take into account was the location of the plane crash that we were designing the shelter for. The surveillance plane had reported that four people were injured and exposed to the harsh conditions of the Cabinet Mountains. Since the Cabinet Mountains are known for their harsh, cold, and extremely dangerous weather conditions, our plans had to provide an environment warm enough to protect the four inhabitants from acquiring hypothermia, a dangerous condition occurring when the normal homeostasis of the human body is upset, and the body temperature drops, which slows down the body's functions. This, if left untreated, causes eminent death, or at least, even if treated, causes after just a few hours of it's first signs, causes shock or amputation if the blood's circulation is upset.

Throughout different procedures, we experimented with various designs. Some of the designs we used included basic squares, rectangles, and pyramids. We took into account different shapes for runoff for snow and ice, as well as rain, and any other forms of precipitation. Because the structure has to be made with energy efficient materials also, we fused them into the shelter's plans. We experimented with some of the more complicated plans we had, and also with some of the more fundamental ones, because sometimes the most efficient, safest designs, are the simplest ones. Also, plans for food storage and suitable bedding were added.

TEST RESULTS

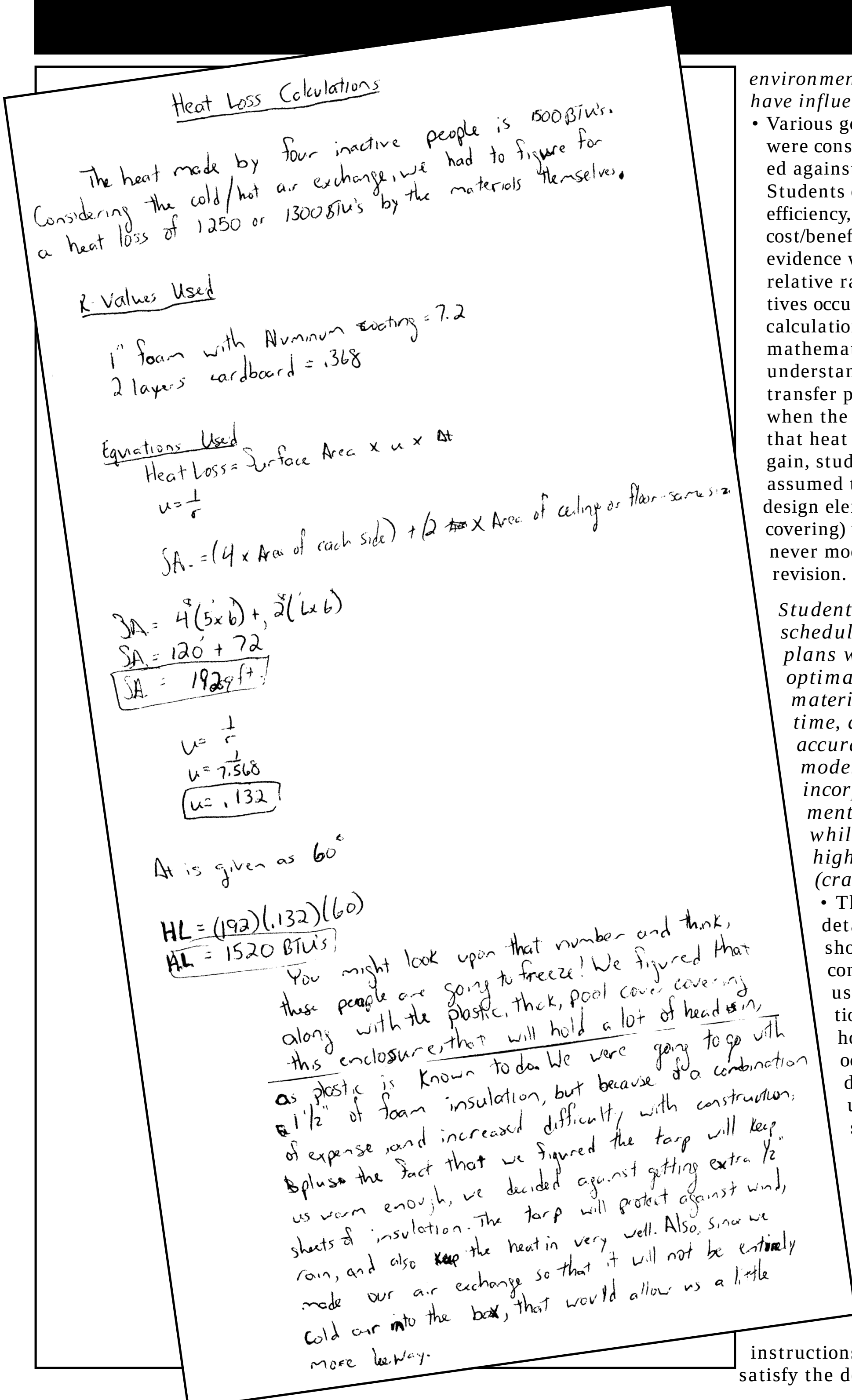
Time (am.)	Outside Temp(F)	Inside Temp(f)
9:25	34.00	42.00
9:35	34.00	54.00
9:45	35.00	59.00
10:05	35.00	64.00
10:20	38.00	69.00
10:45	38.00	69.00
10:55	35.00	68.00
11:07	34.00	68.00
11:13	34.00	72.00
11:15(end)	34.00	70.00

Performance Indicators and Commentary

Students initiate and carry out a thorough investigation of an unfamiliar situation and identify needs and opportunities for technological invention or innovation.

- Students investigated the situation and clarified the problem. A stronger response would have been a more detailed analysis of weather conditions, including quantitative data relative to average wind speed and snow fall.

Students generate a number of creative solution ideas, explore possible refinements of significant functional elements, and use mathematical and functional modeling techniques to predict possible outcomes; choose the optimal solution to the problem, assessing ideas against design criteria and constraints; explain how economics, ergonomics, and



Heat Loss Calculations

The heat made by four inactive people is 1500 BTU's. Considering the cold/hot air exchange, we had to figure for a heat loss of 1250 or 1300 BTU's by the materials themselves.

R Values Used

1" foam with Aluminum coating = 7.2
2 layers cardboard = .368

Equations Used
Heat Loss = Surface Area x u x Δt
u = 1/r

SA = (4 x Area of each side) + (2 x Area of ceiling or floor - same size)

SA = 4(5x6) + 2(6x6)
SA = 120 + 72
SA = 192 sq ft

u = 1/r
u = 1/7.568
u = .132

Δt is given as 60°

HL = (192)(.132)(60)
HL = 1520 BTU's

You might look upon that number and think, these people are going to freeze! We figured that along with the plastic, thick, pool cover covering this enclosure, that will hold a lot of heat in, as plastic is known to do. We were going to go with a combination of 1 1/2" of foam insulation, but because of expense and increased difficulty with construction, plus the fact that we figured the tarp will keep us warm enough, we decided against getting extra 1/2" sheets of insulation. The tarp will protect against wind, rain, and also keep the heat in very well. Also, since we made our air exchange so that it will not be entirely cold air into the box, that would allow us a little more leeway.

environmental considerations have influenced the solution.

- Various geometric shapes were considered and evaluated against design criteria. Students considered energy efficiency, ergonomics, and cost/benefit tradeoffs. No evidence was shown that relative ranking of alternatives occurred. Heat loss calculations show evidence of mathematical modeling and understanding of heat transfer principles. However, when the analysis showed that heat loss exceeded heat gain, students simply assumed that certain revised design elements (e.g., plastic covering) would suffice, and never modeled or tested the revision.

Students develop work schedules and working plans which include optimal use and cost of materials, processes, time, and expertise; accurately construct a model of the solution, incorporating developmental modifications while working to a high degree of quality (craftsmanship).

- The drawings lack detail but annotations show that students considered material usage and construction details such as how air exchange occurs. Assembly directions indicate understanding of spatial relationships and technical assembly methods and the ability to communicate a complex process in a concise format. Pictograms were not included, thus the assembly instructions did not completely satisfy the design criteria.

Students in a group setting, devise a test of the solution relative to the design criteria, and perform the test; record, portray, and evaluate performance test results through quantitative, graphic, and verbal means; use verbal and graphic techniques to effectively and persuasively present conclusions, predict impacts and new problems, and suggest and pursue modifications.

- Data collected during testing of the structure compares outside to inside temperature. The data indicates that the structure was effective in providing a warmer interior; however the students did not address the fact that the outside temperature during the testing (32° F), was higher than the specified design temperature (20°F). The display of results could have been enhanced by graphs, and by a discussion of what source heated the structure under test.