

Subjects: Mathematics and Language Arts

Electronic Installation Business Planning

Grade Level: 8th

Written: June, 2012

Lesson Overview

Overview:

This lesson is specifically designed to incorporate real world procedures and figures essential in running an electrical contracting business.

Implementation and “Product”:

Considering the middle school age group; this lesson includes controlled samples of larger scaled projects which should be adjusted according to the focus groups overall ability.

In addition to gauging the level of challenge; it is assumed that this is a hypothetical model that represents real world business planning.

Incentives:

This is a three-part lesson plan that may present some difficulty in maintaining student engagement; so proper planning is recommended. Educators should involve some reward system at age levels below secondary education. An incentive will ensure buy-in for what may be one of the most valuable insights to the business world that your students will encounter or be exposed to prior to actual employment.

In this lessons final task; students will engage in a “group bid” where they will vote on a winner amongst their peers using a professional-like process. The reward for the project will be extra credit and/or lunch. I plan on having a lunch truck available for the winning team during their lunch period if possible.

Depth of Lesson:

Running a successful business is not an easy task. All of the elements involved in running such a business requires years of research and hard work. Additionally, this is the kind of research that undergoes constant adjusting and revamping that are essential in keeping a business afloat or profitable. Please treat this lesson in the same manner. Feel free to modify or rewrite anything to suit your needs as a teacher and the needs of your students’. Throughout the lesson it is imperative to stress the importance of mathematics. Mathematics runs deeply in all stages of any business model, especially those that involve estimating and contracting official bid

work; not limited to electrical installation contracts.

As a side note and as a fun metaphorical motto I will stress this quote: “Always begin with a budget, and reap nothing but profits thereafter!”

Materials Included in this Lesson
(please see end of this document
for these materials).

- Pricing Sheet Matrix
 - actual
 - adjusted
- Blueprints or “Minis”
 - individual mini
 - group mini
- Cornell Note-Taking Sheets
 - overhead and profit model
- Group Bid Sheet
- Sample Bid Sheet

Other Materials for this Lesson

Please see individual lessons below for materials lists. Materials will also vary depending on school site and teacher necessities.

Skills the Student will Learn

Please see individual lessons below for skills, goals, and objectives

Student Deliverables

- Lesson notes
- Calculated worksheet
- Bid for Builder
- Lesson Evaluation

Length of Lesson: 3-4 Days

Lesson One: About The Business (1-2 Days)

Topic: The Stages of the Electrical Installation Business and “The Bid Process”

CA Standards addressed (includes all 3 lessons):

Number Sense

- 1.1 Read, write, and compare rational numbers in scientific notation (positive and negative powers of 10) with approximate numbers using scientific notation.
- 1.2 Add, subtract, multiply, and divide rational numbers (integers, fractions, and terminating decimals) and take positive rational numbers to whole-number powers.
- 1.3 Convert fractions to decimals and percents and use these representations in estimations, computations, and applications.

- 1.7 Solve problems that involve discounts, markups, commissions, and profit and compute simple and compound interest.

Algebra and Functions

- 1.1 Use variables and appropriate operations to write an expression, an equation, an inequality, or a system of equations or inequalities that represents a verbal description (e.g., three less than a number, half as large as area A).
- 1.2 Use the correct order of operations to evaluate algebraic expressions such as $3(2x^2 + 5)$.
- 1.3 Simplify numerical expressions by applying properties of rational numbers (e.g., identity, inverse, distributive, associative, commutative) and justify the process used.
- 4.1 Solve two-step linear equations and inequalities in one variable over the rational numbers, interpret the solution or solutions in the context from which they arose, and verify the reasonableness of the results.
- 4.2 Solve multistep problems involving rate, average speed, distance, and time or a direct variation.

Mathematical Reasoning

- 1.2 Formulate and justify mathematical conjectures based on a general description of the mathematical question or problem posed.
- 1.3 Determine when and how to break a problem into simpler parts.
- 2.1 Use estimation to verify the reasonableness of calculated results.
- 2.2 Apply strategies and results from simpler problems to more complex problems.
- 2.5 Use a variety of methods, such as words, numbers, symbols, charts, graphs, tables, diagrams, and models, to explain mathematical reasoning.
- 2.6 Express the solution clearly and logically by using the appropriate mathematical notation and terms and clear language; support solutions with evidence in both verbal and symbolic work.
- 2.7 Indicate the relative advantages of exact and approximate solutions to problems and give answers to a specified degree of accuracy.
- 2.8 Make precise calculations and check the validity of the results from the context of the problem.
- 3.1 Evaluate the reasonableness of the solution in the context of the original situation.
- 3.2 Note the method of deriving the solution and demonstrate a conceptual understanding of the derivation by solving similar problems.
- 3.3 Develop generalizations of the results obtained and the strategies used and apply them to new problem situations.

Algebra

- 1.0 Students identify and use the arithmetic properties of subsets of integers and rational, irrational, and real numbers, including closure properties for the four basic arithmetic operations where applicable
- 5.0 Students solve multistep problems, including word problems, involving linear equations and linear inequalities in one variable and provide justification for each step.

- 10.0 Students add, subtract, multiply, and divide monomials and polynomials. Students solve multistep problems, including word problems, by using these techniques.
- 13.0 Students add, subtract, multiply, and divide rational expressions and functions. Students solve both computationally and conceptually challenging problems by using these techniques.

Reading

- 1.3 Use word meanings within the appropriate context and show ability to verify those meanings by definition, restatement, example, comparison, or contrast.

Reading Comprehension

- 2.1 Compare and contrast the features and elements of consumer materials from documents (e.g., warranties, contracts, product information, instruction manuals).
- 2.5 Understand and explain the use of a complex mechanical device by following technical directions.
- 2.6 Use information from a variety of consumer, workplace, and public documents to explain a situation or decision and to solve a problem.

Writing Applications

- 2.5 Write documents related to career development, including simple business letters and job applications:
 - a. Present information purposefully and succinctly and meet the needs of the intended audience.
 - b. Follow the conventional format for the type of document (e.g., letter of inquiry, memorandum).
- 2.6 Write technical documents:
 - a. Identify the sequence of activities needed to design a system, operate a tool, or explain the bylaws of an organization.
 - b. Include all the factors and variables that need to be considered.
 - c. Use formatting techniques (e.g., headings, differing fonts) to aid comprehension.

Grammar

- 1.5 Use correct punctuation and capitalization.

Spelling

- 1.6 Use the correct spelling conventions.

Comprehension

- 1.1 Analyze oral interpretations of literature, including language choice and delivery, and the effect of the interpretations on the listener.
- 1.2 Paraphrase a speaker's purpose and point of view and ask relevant questions concerning the speaker's content, delivery, and purpose.

Speaking Applications

- 2.3 Deliver research presentations:

- a. Define a thesis.
- b. Record important ideas, concepts, and direct quotations from significant information sources and paraphrase and summarize all relevant perspectives on the topic, as appropriate.
- c. Use a variety of primary and secondary sources and distinguish the nature and value of each.
- d. Organize and record information on charts, maps, and graphs.
- 2.4 Deliver persuasive presentations:
 - a. Include a well-defined thesis (i.e., one that makes a clear and knowledgeable judgment).
 - b. Differentiate fact from opinion and support arguments with detailed evidence, examples, and reasoning.
 - c. Anticipate and answer listener concerns and counterarguments effectively through the inclusion and arrangement of details, reasons, examples, and other elements.
 - d. Maintain a reasonable tone.

CTE Standards addressed (includes all 3 lessons):

Residential and Commercial Construction Pathway

- D1.2 Calculate required materials for residential construction applications.
- D4.1 Interpret and use residential construction blueprints and specifications.
- D4.2 Understand how to estimate materials from blueprints and specifications.
- D4.3 Understand the sequencing of events for specific construction projects.
- D4.4 Solve common residential construction problems, such as framing, plumbing, and electrical, by using the official codes adopted by the state and local building standards commission.
- D4.6 Understand customer service/relations as applied to project management and wholesale and retail sales.
- D6.2 Understand the processes and materials (e.g., structural, electrical, mechanical, finish) appropriate to the architectural design and residential construction.
- D6.4 Understand the phases of residential and commercial construction.

Materials Needed:

- Cornell notes/Notebook/Loose leaf binder paper
- Pencils
- Highlighter
- Calculators
- Overhead Projector for Power Point Presentation
- A real “mini” for a home
- Material Matrix Sheet

Time needed: About 2-3 class days (180 minutes total). Homework (*Day 1*) is to ask adults about the many processes entailed in their line of work. Homework (*Day 2*) students will

estimate the total cost (material + labor + tax) of just the electrical outlets in one of the living quarters at their residence.

General Goals:

Students will learn that everything has a process. Nothing is done correctly unless the proper steps and planning are administered. There is an order to everything: making everything mathematics.

Specific Objectives:

- Students will learn/reengage their basic math (add, subtract, multiply divide)
- Students will learn/reengage with ratio and scale
- Students will learn/reengage with equations, functions, and formulas
- Students will learn/reengage with calculating simple sales tax
- Students will learn about insurance taxes and
- Students will practice/participate in the calculation of an actual bid of a home
- Students will take notes and learn some electrical installation vocabulary
- Students will identify the three stages: Trench, Rough, and Trim

Anticipatory Set:

Teacher tells students they have the opportunity to calculate what a company may charge for an actual contract bid. Teacher will show them miniaturized blueprints (“mini’s”) of actual structures used by Rayco Electronics. In addition to some applied math; students will be debriefed with background information and language used across this type of industry.

Procedure:

Day 1:

1. Open up the discussion of practices involved with running a contracting business. Begin with, “What do you think is required in running a business...lets assume an electrical contracting business?”
2. Lead students through each process but be careful enough to not lose focus on the aspects of the electrical contracting business.
3. Describe the general process in detail or to the extent of knowledge on the 3-step process known as Trenching, Roughing, and Trimming. Discuss relationship of this 3-step process and the actual bid. Focus the classroom attention on what the cost of electric installation may be and develop lesson around the importance of the bid.
4. Provide students with a generic example bid and discuss pricing. Share the mathematical model for calculating a bid cost. Identify it directly with Algebra.
5. Calculate the potential cost of the classroom together (just basic outlets).

Day 2:

6. Share the processes that several students have learned about from their parents/guardians/teachers. Revert back to the bid and remind students that none of these

processes occur without a bid.

7. Demonstrate a sample bid and have students take notes on that process; reminding them that they will have their chance to practice it and implement their knowledge within a group.
8. Have students design a room/pick a room from home or one of the “mini’s” and give an estimate on just ordinary outlets including cost, labor, and tax. Complete or review individual bid for homework.

Activity/Lesson Two: Calculating A Proper Bid (1 day)

Topic: Calculating a bid individually and as a class.

CA Standards addressed (includes all 3 lessons):

Refer to list in Activity/Lesson One

Materials Needed:

- Cornell notes/Notebook/Loose leaf binder paper
- Pencils
- Highlighter
- Calculators
- Overhead Projector
- A real “mini” for a home
- Material Matrix Sheet

Time needed: 1-1 ½ hours in class plus homework. Homework is to complete individual bids and work out a strategy for the group bid.

General Goals:

Students are participating in a guided lesson of how a bid is calculated. They are following the exact steps in the same manner that was presented to me by an actual estimator. Provide adjusted figures (hourly wage, taxes, insurance, labor hours...etc.).

Specific Objectives:

- Students will read schematics or mini’s accurately
- Students will use notes to calculate figures involved in producing a bid
- Students will use a matrix to itemize a bid and produce a bid cost

Anticipatory Set:

Familiarize students with worksheets. Provide sample mini on overhead and perform certain

calculations together and then individually. Check work using cooperative learning devices. Establish heterogeneous groups for group bid based on acquisition of the concept.

Procedure:

1. Share examples from the previous nights assignment. Discuss some figures and answer a few questions about fixtures in their room. Be sure that students are equipped with their notes.
2. Show an actual mini. Provide students with a legend or list of items on the schematic. Explain the importance of efficiency and discuss solutions of keeping track of the items to be calculated in producing a bid.
3. Demonstrate the process of calculating a bid. Introduce the idea of a matrix or spreadsheet that conveniently simplifies the entire bid calculating process.
4. Share work and pick team leaders/teams. Define the expectations and reward.

Taking the lesson further:

- Create a false bid with errors and have students fix a bid

Activity/Lesson Three – Writing An Entire Group Bid (1 day)

Topic: Students will propose a bid as a group.

CA Standards addressed (includes all 3 lessons):

Refer to list in Activity/Lesson One

Background Knowledge/Skill Needed:

- Student must know how to calculate tax
- Students must read schematics of a mini
- Students must use notes to calculate figures involved in producing a bid
- Students must use a matrix to itemize a bid and produce a bid cost

Note: Teacher may decide to do a review of these items prior to this lesson

Materials Needed:

- Mini
- Matrix sheets
- Bid sheet
- Sample Bid

Time needed: 60 to 90 minutes.

General Goals:

Students will write a professional bid. The groups will turn in their bids before the deadline.

Specific Objectives:

- Students will read technical writing
- Students will write and organize bids using technical writing
- Students will calculate bids
- Students will complete the formal bid
- Students will fairly assess each others work

Anticipatory Set:

Ask students: “How much money they think the contract would cost?” Expect students to turn in a complete bid. Use these two tasks to decide on the winning group. In the event of the tie; have a trivia based playoff with open notes (best of 5 questions).

Procedure:

Day 1:

1. Provide each student with matrix and mini for the group. Only assist by pointing out useful material in the notes.
2. Outline the expectations of the final bid; include a judging criterion. Document the estimated bid for each group, the order of which the bids are turned in, and votes casted for final group bids.
3. Announce the winner.

ASSESSMENT (please see assessment sheets)

Enrichment Suggestions

Have students design their own rooms. Geometry students may wish to do actual scale models. Students can also develop real world situations with missing values or problem solving scenarios that are directly related to equation solving. For example, “ Tom left the warehouse and it is 80 miles away. He forgot to bring 30 cables to the building site. Will it cost the company more for him to go back and get the cables or pay for new cables at Home Depot, which is 1 mile away and charges \$2.10 more per cable? Assume the cost of going back to the warehouse costs about \$45 in total company cost.”

Student Resources

Notes developed through discussion and PowerPoint notes.

Lesson Plan Relevance To Externship

The externship was at Rayco. Electronics. The main purpose of the business is to bid electrical contract designs proposed by builders in the State of California. All information including pricings, have been altered to protect their competitive market and industrial integrity.

Assessment Ideas

Presentation:

Student should give a 2-minute presentation about their Plan. They should emphasize both the functionality and aesthetic value of their plans. Rubric is shown on next page.

FINAL PRODUCTS: Student should have a packet including the following:

- The mini
- The matrix completed and neat
- The bid filled out correctly
- Worksheet of calculations

Good questions to ask during the presentation:

1. How many workers would you hire and, based on that number, how long would this project take?
2. What was the most challenging part of the project?
3. How important was planning before working on the bid?
4. Do you think you could manage a project of this size now that you've done all the plans and bidding? Of course with the proper electrical training?

Rubric for Electrical Installation Business Project

TASK/PRODUCT	EXCEEDS EXPECTATIONS (4)	MEETS EXPECTATIONS (3)	APPROACHES EXPECTATIONS (2)	DOES NOT MEET EXPECTATIONS (1)
Notes	Student has met the expectations. Clean notes and the main ideas of the project are present.	Student has met the expectations. Disorganized notes and the main ideas of the project are present.	Student has met the expectations. Disorganized notes and the some ideas of the project are present.	Little or no notes taken.
Individual Mini	Successful calculation of the desired “mini”. Neat work and organized.	Successful calculation of the desired “mini”. Sloppy work or disorganized.	Slight miscalculation of the desired “mini”. Sloppy work and disorganized with few mistakes.	Many miscalculations, sloppy work, and disorganized.
Group Bid	Bid has very effective, organized layout and clearly demonstrates material and labor costs. Bid correctly calculates costs. Students demonstrate a fair model that includes a rational profit.	Bid has an effective, organized layout and closely demonstrates material and labor costs. Bid calculates costs with minor errors. Students demonstrate a model that includes a profit.	Bid has fairly effective layout. Bid is mostly correct in terms of calculating costs. Bid calculates costs with some errors. Students demonstrate a model that includes a profit.	Bid is not in an effective format. Bid has many errors in calculations. Bid calculates costs full of errors. Students lack a model.
Work Ethic	Students are actively involved in each task. All 4 days without redirection or absence.	Students are actively involved in each task. All 4 days without redirection or absence. Completed and correct worksheets with minor errors.	Students are slightly involved in each task. Only one day of redirection or absence. Completed and correct worksheets with some errors.	Students are not involved in each task. More than one day of redirection or absence. Completed and correct worksheets with many errors.



The Electrical Contracting Business

- Rayco
- Elite Power
- Frickes
- Griffin
- Apex
- Gubrud

What does an electrical contracting business do exactly?

- Provide electricity to buildings both commercial and residential
- Install lighting and various electrical outlets
- Work alongside other contractual businesses everyday in community and business developments
- Allow safe and regulated usage of electric power

Why does anyone need an electrical contractor?

- Proper installation of electrical equipment is a skilled craft
- Safety must be maintained and rules must be followed because electricity is dangerous and should be manipulated by trained individuals
- Building homes and businesses or any other work spaces that rely on electricity to function in today's society and economy

When and where are electrical contractors needed?

- Whenever a home or community is being built
- Whenever a business is established
- Wherever there is a need to power appliances or electrically dependent machinery
- Where roads, railways, or airways needing lights or accessible electricity

How do electrical contractors work?

ELECTRICAL CONTRACT WORK CAN BE CONSOLIDATED INTO 3 SIMPLE STEPS, AND THEY ARE:

- STEP 1 EMPLOYER/BUILDER PROPOSES A JOB TO SEVERAL CONTRACTORS
- STEP 2 CONTRACTORS DESIGN/SUBMIT BIDS
- STEP 3 EMPLOYER HIRES A CONTRACTOR FOR THE JOB

What's Next?

After an electrical contractor is notified that their bid has been accepted; the builder notifies all other contracting parties about deadlines, schedules, and alterations necessary to complete building. Schedule planning; is possibly the most challenging part of completing a job site due to the construction errors and other unforeseen circumstances which may arise during the building process.

The 3 Stages Of An Electrical Contract Following A Bid

TRENCHING – the beginning stage of making trenches in the ground and installing the main panel

ROUGHING – wiring throughout the entire facility or development and stage of planning changes or alterations

TRIMMING – installation of all of the fixtures

**none of this occurs without the acceptance of a bid*

The Bid

The bid is an estimated value amount which the contractor will agree to complete the electrical installation job that was proposed.

(Recall that the builders invite contractors to calculate bids, contractors design/submit those estimates, and then the contractor is chosen by the builder.)

What Is In The Cost Of A Bid?

- Labor Costs
- Material Costs
- Overhead Costs
- Insurances
- Taxes
- Profit

The Formula

Let m = raw material cost

l = labor hours

r = hourly rate peace rate \$18

b = burden % (state mandated insurance for employees)

t = tax % 7.5%

O = over head %(cost of all misc.) 20%

P = profit % 2%

Price of the bid =

$$[[[m*(1+t)]+[l*r*(1+b)]]*(1+O)](1+P)$$