Making Connections: A Thematic Mathematics Project for Grade 7

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Here is the teacher's dilemma: students are motivated by new experiences in mathematics, but many lack the basic skills and understanding of concepts that they need to be successful when the pace of instruction quickens. For example, when introducing the multiplication property of equality to solve $ax = b$, I find that many Grade 7 students have forgotten how to multiply fractions and decimals. They are interested in the prospect of learning something new, but their enthusiasm is dampened because they cannot perform simple computations. Even after years of drill and practice, familiar algorithms have not reached long-term memory.

Slavin (1994, 193) describes short-term memory as "a bottleneck through which information from the environment reaches long-term memory." I believe that trying to force basic skills and concepts through this bottleneck with periodic intensive drill-and-practice sessions is not effective for many students. Such practice is a temporary fix, and the redundancy of this effort holds no interest for students. During 20 years of teaching middle school, I have learned that practice is essential to success but that it is effective only when the goals are clear, meaningful and rewarding. Perhaps most important, I believe that effective practice is sustained only through self-motivation. To address these issues, I designed a year-long, career-based project to practise some of the basic skills that lay a foundation for algebra, such as measurement in both the customary and the metric system, fractions, decimals, percents and proportions. The rationale for this approach was that frequent rehearsal of these skills in a meaningful context and over an extended period would help students transfer them to long-term memory.

Project Overview

The project was divided into three units to correspond to three marking periods (fall, winter and spring). Unit 1, titled Drafting, included a basic introduction to mechanical drawing skills, design format and function. The curriculum objectives were to review operations with fractions, practise measurement skills, introduce the multiplication property of equality, and apply each of these skills and concepts to designing a floor plan for a one-story summer cottage. Unit 2, Real Estate, introduced terms and practices through an elaborate simulation. Students were asked to select a cottage design from unit 1, purchase a building site, build a cottage using current building costs and try to sell this property for a profit. The objectives for this unit were to review operations with decimals and percents and apply these skills to determine brokers' fees and closing costs. In unit 3, Investment, student teams invested the profits from their property sales in the stock market. This unit targeted the relationship between fractions and decimals and demonstrated the value of memorizing conversions between basic fractional units, such as fourths, thirds and eighths, and their corresponding decimals.

My pre-algebra class met four times a week, for three 40-minute periods and one 80-minute period. Half of the 80-minute period was allotted each week throughout the year for this thematic career-based project. The remaining time on that day and subsequent periods each week followed the traditional curriculum, emphasizing problem solving and drill and practice.

Drafting

To set the stage for success, the class reviewed basic measurement skills, multiplication with fractions and the multiplication property of equality. Using these skills, my students were able to measure distances accurately with a ruler and convert inches to feet using a scale of ¼ inch = 1 foot. Students were then introduced to drafting tools, including the T square, drawing board, right triangles and compass, and were given algorithms for four practice drawings, a rectangle, an L shape, a T shape and design symbols.

These exercises were quite challenging, and students benefited from peer coaching and frequent review sessions.

After completing these exercises, students received an overview sheet for designing their cottages according to the following guidelines.

- The maximum building size was 24 feet by 36 feet.
- The scale for the drawings was 1/4 inch = 1 foot or 1/8 inch = 1 foot.
- The maximum number of rooms was five.

The need for these parameters had become clear during the introductory exercises. Spatial sense is sometimes an innate gift, but more often it is an acquired understanding. Grade 7 students often have no concept of appropriate room dimensions and, consequently, exhibit little understanding of form and function. For example, one of my students was convinced that an indoor pool could be placed in his cottage, along with a 2' × 3' bathroom and a 5' × 3' bedroom with no windows. The game room, however, was understandably a priority for this student; its dimensions were 15' × 20'.

Given students' lack of spatial sense, my second objective was to model functional spaces. Students were required to measure each room in their homes and comment briefly on the advantages and disadvantages inherent in each space. One of my students commented, "My bedroom is 10' × 12' and this is big enough for my desk, bed, and dresser, but my closet is way too small, and I only have one window . . . it gets hot in the summer." I was surprised by the enthusiasm that this assignment generated; students were eager to share their findings and defend their beliefs, but they were also open to new ideas about form and function.

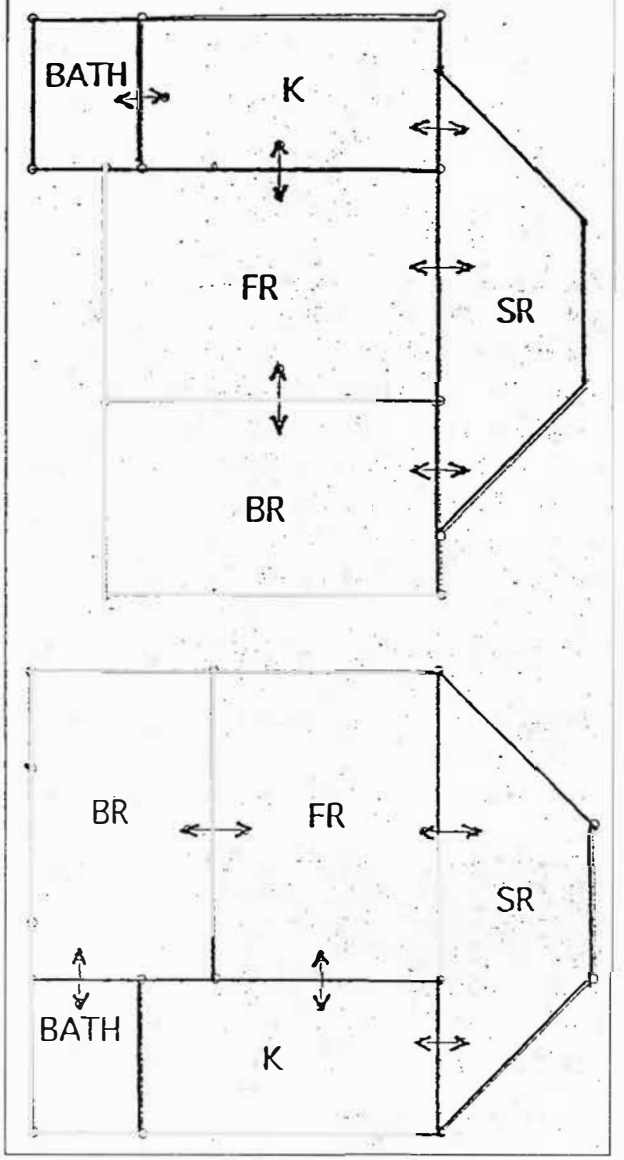
The third objective was to create a functional living space. First, students were asked to cut out graph-paper models of appropriately sized rooms and to piece them together in functional patterns. For example, a bedroom, sunroom, kitchen and family room can be arranged to demonstrate a variety of walking patterns, light exposures and proximities. In addition, once the pattern is selected, room dimensions can be altered slightly to lower building costs. Figure 1 shows two functional patterns created by one of my students.

When the rough drafts were complete with room assignments and symbols for doors and windows, students began their final drawings on oak tag using mechanical drawing tools. Students chose one of two scales, 1/4 inch = 1 foot or 1/8 inch = 1 foot, on the basis of the size of their design. Students were reminded to draw pale lines with a number 3 pencil to facilitate erasures. The final drawings were checked for errors and graded on accuracy and function.

When corrections were complete, the designs were given numbers and placed on tables around the room for viewing. The names of the designers were covered. Each student was given a ballot and asked to record the number of the drawing that best demonstrated the qualities of functional living space, solar efficiency and creativity. The room was full of energy for about 20 minutes. I overheard one of my students say, "There are too many doors in this den—where would you put a couch and a TV?" Another commented, "There isn't enough light in this kitchen; I would put another window on the west wall."

Figure 1

Two Functional Designs for One Student's Cottage



The winning design was taped to the chalkboard, and we reviewed what distinguished it from the others (see Figure 2). After this discussion, we displayed all the drawings in the front hall.

Real Estate

Unit 2 began in January with a review of place value, percents and multiplication with decimals. Our goal was to purchase an appropriate building site for our award-winning design. Students were asked to define a region for the search; given our proximity to the sea and several resort areas, they chose to look along the coast between Noank and Stonington, Connecticut. Ann Burgess and Kay Hill, two local real estate agents, volunteered their time to show us four waterfront properties.

After recovering from the initial shock of waterfront prices, my students listed the advantages and disadvantages of each property using the following criteria: (1) access to water, (2) zoning regulations, (3) taxes, (4) water and sewer requirements, (5) acreage, (6) total cost, (7) soil composition and (8) resale value with proposed building. This lesson was a wonderful opportunity to introduce real estate terms and practices, and the students were amazed at the number of factors to be considered when purchasing a property.

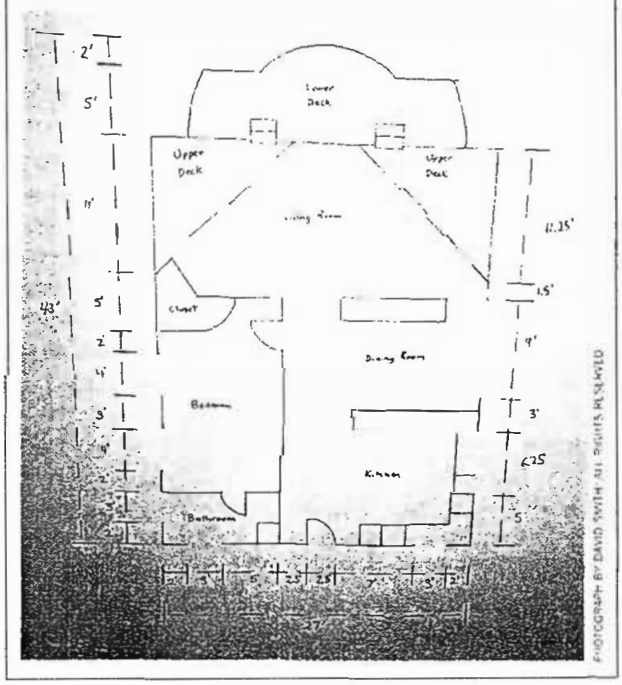
One student was concerned about Amtrak's high-speed rail service adjacent to a property in Mystic; another questioned the cost of insurance in a flood zone; and one student thought that our cottage was not big enough to increase the value of a large property with deep waterfront. She argued that the surrounding homes were considerably larger and commented, "People with a lot of money build bigger homes." This comment was particularly interesting to me because it showed the student's capacity to look beyond current needs and consider this purchase as a long-term investment.

After considerable discussion, we voted unanimously to purchase a property in Stonington with a breathtaking view of the Mystic River. We filled out a mock sales contract with an offer that was $20,000 less than the asking price, and, to our surprise and delight, the offer was accepted. We then consulted with a contractor to determine building costs per square foot and calculated closing costs. The sum of the costs to buy the lot and build our cottage was $380,000.

After we had "built" our cottage on its beautiful waterfront site, we went back to our real estate agents to conduct a market comparison and fill out a listing agreement to sell the home. The agents showed us three waterfront homes that had been recently sold or were currently on the market, were similar in style and size to our cottage, and had comparable lot sizes. Determining a sales price proved to be challenging because the market comparisons presented as many differences as similarities. Students were reminded to ask for a higher price than they thought they could get but not so high as to discourage potential buyers. This time the discussion was heated, but we finally agreed on an asking price of $445,000. Next we discussed the commission for our agent, which is usually 6 percent of the sales price. My students calculated the commission for a variety of sales prices to get a sense of this cost. After this activity, several students wanted to know how they could become real estate agents.

During the next meeting, our agents conducted a mock sale with fictional buyers from New York City, a family of four with a 36-foot sailboat. We refused their first offer of $410,000, and considerable debate ensued. Several students were concerned that we would not make enough profit from the sale after deducting a commission of $24,600, and many wanted to hold out for another buyer. Our real estate agent discussed the advantages and disadvantages of holding out and asked us whether we were prepared to rent the property to help with our monthly costs.

Figure 2
The Winning Cottage Design



My students enjoyed this role playing, and after much debate, we agreed on a price of $437,000. After closing costs and taxes, the profit on our investment was approximately $30,000.

Investment

After a review of the conversions from fractions to decimals and an overview of investment terms and principles, students were given a set of guidelines for investing their profits in the stock market. The class was divided into teams of two, and each team received the $30,000 profit from our sale to invest over an eight-week period. Their initial assignment was to survey peers, parents and neighbors about wise investment opportunities. Local companies, such as Pfizer, Dow Chemical and Stop & Shop, were attractive to my students, as were companies related to the computer industry, such as Microsoft and Yahoo. Their choices often reflected consumer trends, both because students have an excellent grasp of the youth market and because their interests are uncomplicated and highly focused. One team invested a large portion of its profits in Yahoo because personal experience convinced the two students that it is a powerful search engine. Another team selected Stop & Shop because the students had witnessed how successful a new superstore was in their community.

Each team was required to buy two blue-chip stocks and two stocks from NASDAQ. Students kept track of their investments weekly with a stock-review sheet (see Figure 3). At the end of four weeks, the teams were given the opportunity to sell unsatisfactory stock and reinvest their money. Occasional groans and shouts of "Yes!" and "Show me the money!" were testaments to students' interest in the project. Students began to follow the market daily and make conjectures about why stock values rose and fell. Students memorized decimal conversions and used calculators almost exclusively to determine the total value of their stock. See Figure 4 for two examples of student work.

At the end of eight weeks, students calculated their profits and losses and submitted their worksheets. The teams were graded on the following criteria: (1) completion of worksheets, (2) efforts to show work clearly in well-organized steps, (3) accuracy of calculations and (4) cooperation and focus during work periods. As promised at the beginning of the term, I took the top two money-making teams out for a business lunch to celebrate their wise investments and hard work.

Figure 3

Activity Sheet for Stock-Market Project

Stock Market Project Work Sheet

Stock	# of Shares	Original Invest.	Closing Price per share	Change as Decimal	Total Value of Shares Today (closing price × # of shares)	Profit (today's value – original investment)

Work:

Date:

Figure 4

Student Work for the Investment Phase of the Project

Stock Market Project Work Sheet

Stock	# of Shares	Original Invest.	Closing Price per share	Change as Decimal	Total Value of Shares Today (closing price × # of shares)	Profit (today's value – original investment)
AmOnline	100	7293.75	89 3/4	+1.75	8975	1681.25
4Health	918	7917.75	8.625	+2.5	7917.75	0
Yahoo's	75	7335.9375	115 3/16	+.125	8639.0625	1303.125
Pfizers	60	6922.5	106 7/8	−1 15/16	6412.5	−510
						2474.375

Work:

1875

8975
−72

Date: 5/8/98

Stock Market Project Work Sheet

Stock	# of Shares	Original Invest.	Closing Price per share	Change as Decimal	Total Value of Shares Today (closing price × # of shares)	Profit (today's value – original investment)
Amonline	100	7293.75	87.75	−2.25	8775	1481.25
4Health	918	7917.75	7 1/16	−.625	6483.375	−1434.375
Yahoos	75	7335.9375	120.25	−3.75	9018.75	1682.8125
Pfizer	60	6922.5	108	−2.1875	6480	−442.5

Work:

29469.937
10530.063
0625

Date: 5/15/98

11059.75
+ 29469.937
40529.687

Reflections

Two factors were important to the success of this project. First, frequent review of skills during the introduction of each unit was essential for enabling each student to achieve some level of success. For example, a few students did not master basic drafting skills and proportions before the design phase of unit 1, and their motivation dwindled because they depended on the teacher or their peers to perform simple tasks. To overcome this problem, teachers must hold frequent review sessions that are targeted toward specific difficulties.

Second, clear guidelines should be set to ensure cooperative learning for team activities. These guidelines do not require each team to follow the same process for completing the assignment, but the students must understand that each member of the team is responsible for part of the work load. For example, during the Investment unit, two students agreed to review the business section of the newspaper and underline their holdings together, then work through the stock-review sheet separately to verify gains and losses. Another team decided to work through the whole process together. The students alternated responsibilities for locating their investments, reading pertinent business news out loud, recording the data, calculating gains and losses, and checking their work with a calculator. Each approach was effective, and for each team the responsibilities and the expectations for peer interactions were clear.

The central purpose of this project was to design a format for reviewing basic skills that would hold students' interest and ensure long-term retention of these skills. I think that my students were motivated by the format and content, but their retention must be assessed next year. I look forward to discussing this assessment with the students' algebra teacher.

Additional benefits surfaced during the course of the project. First, the project served as a wonderful opportunity to link school and community. My students worked with caring professionals who helped them see the connections between school-based learning objectives and career responsibilities. Second, the components of this project targeted several of Howard Gardner's multiple intelligences, including logical/mathematical intelligence through abstract reasoning, computation and problem solving; spatial and bodily/kinesthetic intelligence through design applications and site planning; and personal intelligence through cooperative learning activities (Gardner 1985). I believe that I was able to meet the individual needs of each of my students while creating a pleasurable and productive experience.

The drafting and real estate portions of this project were designed for a suburban population of middle-level income. Many students will not have the same background, and for them real estate concepts may be unfamiliar. Therefore, more time might be required to define real estate and zoning regulations or to incorporate alternative design projects, such as remodeling apartments or designing a retail space. Regardless of focus, this project should reinforce basic skills, promote student learning and connect fundamental life skills to career opportunities. One of my students underscored this point during a conversation with a peer: "Designing a house isn't so hard," the student said, "not when you know the multiplication property of equality."

Bibliography

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