

# Using DrScheme and the Design Recipe in Algebra

Karen North

Westside High School

Houston Independent School District

70 Patti Lynn

Houston, TX 77024

knorth@houstonisd.org or [knorth@cs.rice.edu](mailto:knorth@cs.rice.edu)

## Abstract

With the support of a grant from Houston A+ Challenge, I developed lessons to use programming to teach algebra because my students had problems developing solutions to word problems. All my Algebra students passed the Texas ninth grade math accountability TAKS test. This success was the result of teaching students to think about and plan solutions with the continuous use of the HTDP design recipe. Student problem-solving skills were enhanced by using graphic lessons and visual products.

I have contributed algebra lessons that emphasize understanding the problem-solving process. These lessons practice processing solutions to problems by developing examples in process charts and on graph paper. Included in these lessons are the Cartesian Plane Program, the Four-Corner Design Recipe, Slope and Graphic Design Lesson, Profit Program Process Chart and My Box Program with physical models.

## 1 Background

### 1.1 Houston A+ Challenge Grant

I have been researching solutions to mastering math and algebra for 20 years and was recently given the opportunity to beta-test my ideas through a combination Pre-AP Algebra-Computer Science class at Westside High School in Houston ISD. This project was funded by a *Teacher as a Researcher* grant from Houston A+ Challenge, [www.houstonaplus.org](http://www.houstonaplus.org).

### 1.2 Computer Science Experience

To develop solutions for computer programs involving math concepts, students must first develop a design recipe with examples for the problem. In my computer science classes I found I often was required to re-teach algebra concepts. By using programming to teach these algebra concepts, I have observed students over and over again finally saying, "Now I get it." These were typically students who made high grades in math classes, yet never really mastered a true understanding of algebraic computation. Watching the dendrites connect in the student's brain and seeing the "light bulb" illuminated was so motivating that I wrote a grant to test this informal research in an algebra class to help students internalize the problem solving process.

By teaching computer science concepts, I have learned new methods for teaching algebra. Students need to practice algebra using methods that involve more than a math question. I first used programming to teach math 20 years ago in Fundamentals of Math on an Apple IIE with BASIC to help students internalize the concept of a variable. I used programming with Logo, Basic and a TI calculator to teach pre-Algebra, Algebra and Geometry. I also used HTML and JavaScript to motivate and display work, as students love to create web pages. All of these programming applications involve using functions and variables, which is an abstract foundation that algebra students must master.

### 1.3 Published Articles

In discussing this idea with other computer science teachers on the National AP Computer Science forum and the Programming Language Team forum, I have found many teachers who observe the same thing. I have written two articles on these topics, which are posted on the College Board site: *Supporting Girls in Computer Science by Programming with Graphics* and *The 'Write' Tool for Computer Science Courses*. I wrote a paper, *Using Programming to Teach Algebra*, which was presented at an International Conference on Math and Science Education.

## **1.4 Resources**

There have been programming applications in math textbooks for years, but few teachers use these due to lack of resources and training. In the first TeachScheme! Workshop at Rice University, I was introduced to DrScheme, which I have found to be the best environment to use programming for improvement of algebra computation skills. This IDE made it possible to develop algebra lessons, as I did not have to teach the syntax of a language, and could focus on the problem-solving process. DrScheme provides a free programming environment that makes implementation of concepts easy. The book, "*How to Design Programs*" (HTDP), adds the step-by-step design recipes to solve algebraic problems.

At a TCEA conference, I met Pamela Ossorio, who found graphics to be the tool she was looking for to help her middle school students with algebra. With Pamela emphasizing the middle school concepts, and my concentration on the high school process, we developed a 6-hour Gifted and Talented Professional Development workshop where teachers can learn to use our problem solving and design tools.

## **2 Research Project**

### **2.1 Demographics**

#### **2.1.1 Westside High School**

WHS completed its 5<sup>th</sup> year in 2005 and is continually trying new things to improve student learning. It is a demographically diverse community of 2800 students. This West Houston community spans the range of upper income housing to lower income apartment developments. The integrated technology program at WHS attracts magnet students from all over Houston.

#### **2.1.2 Experimental Algebra Group**

Typical enrollment of pre-AP algebra courses involves students working at 7<sup>th</sup> grade to 9<sup>th</sup> grade mathematical abilities. More advanced students take Geometry in the 9<sup>th</sup> grade. AP classes are open enrollment in the Houston ISD; therefore some students have not made the transition to abstract thinking and are still working at the concrete level. My experimental group consisted of an ethnically mixed group of 16 female and 4 male 9<sup>th</sup> grade Westside High School students who were placed in this combination computer science-algebra class because they had problems mastering algebra concepts in middle school.

### **2.2 Research Results**

Math performance indicators compared my experimental groups with other WHS students and Houston ISD students. Out of my experimental group, 100% passed the HISD Snapshot tests and 100% passed the state accountability ninth grade math TAKS (Texas Assessment of Knowledge and Skills) Test. This is compared to approximately 60% of the students at Westside High School passing the accountability tests.

Data graphs illustrating the benchmark tests and TAKS results and End-of-Course algebra exam compared with all of Houston ISD are available on the algebra link on my web page at [www.knorth.info](http://www.knorth.info).

The continuous practice throughout the year of writing computer programs that use the design recipe to solve word problems helped students automate the thinking process. Practice in looking for functional relationships, patterns, and constants-variable data and designing graphics was the key to success. A final Houston A+ report and updated lessons will be posted on my website at [www.knorth.info](http://www.knorth.info).

## 3 Algebra Lessons

### 3.1 Cartesian Plane Graphing Points Program

#### 3.1.1 Cartesian Plane Teach-Pak

```
;;-----> Canvas Size <-----
(define L 400)      ;; Length of Canvas
(define M (/ L 2)) ;; Middle
(start L L)        ;; Starts a drawing canvas

;; > X-AXIS and Y-AXIS <-----
(draw-solid-line (make-posn M 0) (make-posn M L))
(draw-solid-line (make-posn 0 M) (make-posn L M))

;;-----> Drawing Commands <-----
;;line: posn posn color -> true
;;Draws a line given the start and end points and a color on a Cartesian
plane
(define (line start end color)
  (draw-solid-line (make-posn (+ (posn-x start)M)
                              (- M (posn-y start)))
                  (make-posn (+ (posn-x end) M)
                              (- M (posn-y end))) color))

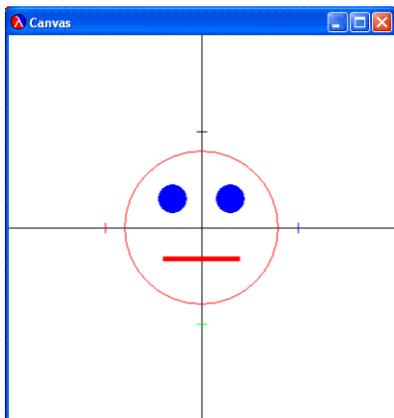
;;circle: posn number color -> true
;;Draws a circle on a Cartesian plane given the center point, radius and a
color.
(define (circle center radius color)
  (draw-circle (make-posn (+ M(posn-x center)
                          (- M (posn-y center)))) radius color))

;;disk: posn number color -> true
;;Draws a solid-disk given the center point, radius and a color on a
Cartesian plane
(define (disk center radius color)
  (draw-solid-disk (make-posn (+ M(posn-x center)
                              (- M (posn-y center)))) radius color))

;;rect: posn number number color -> true
;;Draws a solid-rectangle given the top-left corner point, the length, width
and color
(define (rect corner L H color)
  (draw-solid-rect (make-posn (+ M (posn-x corner)
                              (- M (posn-y corner))) L H color))
```

#### 3.1.2 Student Graphic Product

Students studied the sample Cartesian plane code and explained how the design recipe was used in the development of this Teach-Pak. They then designed graphics to practice plotting points in each of the 4 quadrants, first planning their pictures on graph paper to create examples. Students started with a basic face example and enhanced their person. Each student created a unique graphic and displayed their product and what they learned in a web page programmed with HTML.



### 3.1.3 Cartesian Plane Assessment Test

- Draw a circle or disk inscribed in a square that has a radius of  $\_$  and a center point at the origin.
- Add 2 diagonal lines (slanted lines that are NOT horizontal or vertical).
- The lines should intersect (touch or go through) the center of the circle or corners of the rectangle.
- Plan your work on graph paper first showing all coordinates!!

## 3.2 Four-corner Design Recipe

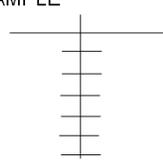
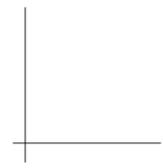
This is a visual display for the design recipe applying rate-of-change problems from slope to comparing the cost of Internet Service using systems of equations, to finding the  $n$ th term in a series. Once students worked out the algebra equation, writing Scheme programs was easy. For guided practice students worked in teams where each member would complete one of the 4 quadrants – the purpose, examples, rules or test.

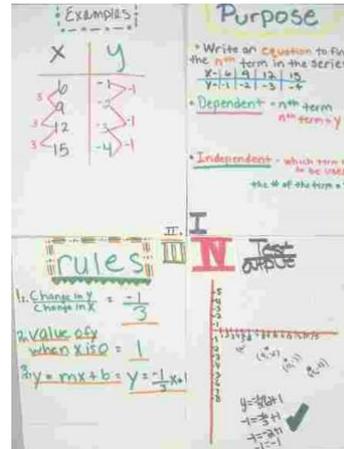
### 3.2.1 Directions

- Fold a piece of paper into 4 parts and label Quadrant I, II, III and IV.
- In the Quadrant I corner, write the purpose, independent and dependent variables, the contract and header of the program.
- In the Quadrant II corner, show examples. These can be a T-Chart, a Process Chart or examples translated from pictures drawn on graph paper.
- In the Quadrant III corner, write the body of the function by studying the pattern from the examples and look for what changes and what remains constant.
- In the Quadrant IV corner, write the test for the function using data from the example and draw a graph to check data for linear functions.

### 3.2.2 Four-corner Template

See my web page for an example of the 4-corner lessons.

A	B
<b>EXAMPLE</b> 	<b>PURPOSE</b> Independent and Dependent Variables
<b>RULES</b> 1. Change Dependent Variable Change Independent Variable 2. Value of Y when X is 0 = 3. Write equation in form $Y = mx + b$ where $m = \text{Change Y} / \text{Change X}$ $b = \text{value of Y when X is 0}$	<b>TEST / GRAPH</b> 



```
;;Find the nth y-coordinate in the series (6, -1) (9, -2) (12, -3) given the x-coordinate.
```

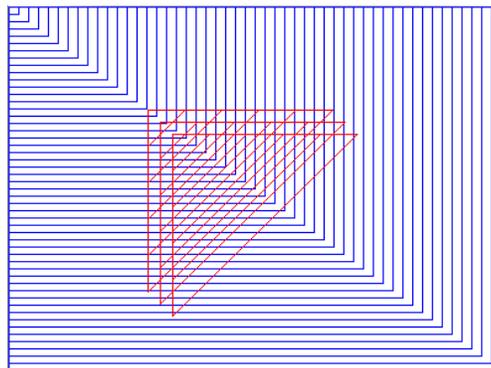
```
;;series: n -> n
(define (series x)
  (+ (* -1/3 x) 1))
(= (series 6) -1)
(= (series 9) -2)
(= (series 12) -3)
```

### 3.2.3 Student Graphic Designs using 4-corner design recipe

Students planned the graphics on graph paper first to look at patterns and decide on the independent variable(s). The 4-corner and HTDP design recipes helped in developing a solution to create their variable graphic. Once they developed their function using the design recipe, they created their designs with patterned function call. The thought process of developing the design was the first step to help students think about solutions. Students found going back to word problems seemed easy after designing variable graphics.

Below are examples and final code for the geometric proportion graphic, the bulls-eye graphic and the trapezoid. The students first worked with the trapezoid in a transformation algebra worksheet. I did not require the use structures, but instead had students enter the x and y coordinates as numbers. Since I was teaching algebra concepts, I felt using computer science syntax for structures complicated the process.

#### Geometric Proportions Graphic



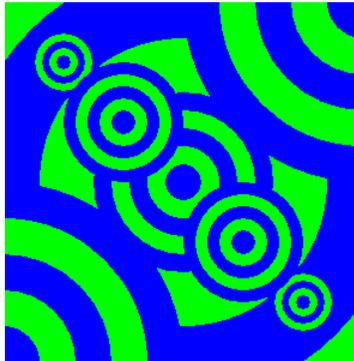
```

;;rect4:3: N N N -> True
;;draws a rectangle with a proportion of 4 to 3 sides that consumes corner
coordinates and the scale factor.
(define (rect4:3 x y f)
  (and
    (draw-solid-line (make-posn x y) (make-posn (* f 4) y) 'blue)
    (draw-solid-line (make-posn (* f 4) y) (make-posn (* f 4) (* f 3)) 'blue)
    (draw-solid-line (make-posn (* f 4) (* f 3)) (make-posn x (* f 3)) 'blue)
    (draw-solid-line (make-posn x (* f 3)) (make-posn x y) 'blue)))

;;triisoc: N N N -> True
;;draws an isosceles triangle with proportional sides that consumes the point
position coordinates and the scale factor
(define (triisoc x y f)
  (and
    (draw-solid-line (make-posn (+ x f) y) (make-posn x (+ y f)) 'red)
    (draw-solid-line (make-posn x y) (make-posn (+ x f) y) 'red)
    (draw-solid-line (make-posn x (+ y f)) (make-posn x y) 'red)))

```

### Bulls-eye Graphic



```

;;bullseye: posn n -> true
;;draws a bullseye given the position of the center and radius of the largest
circle
(define (bullseye center radius)
  (and
    (draw-solid-disk center radius 'blue)
    (draw-solid-disk center (- radius (/ radius 5)) 'green)
    (draw-solid-disk center (- radius (* 2(/ radius 5))) 'blue)
    (draw-solid-disk center (- radius (* 3(/ radius 5))) 'green)
    (draw-solid-disk center (- radius (* 4(/ radius 5))) 'blue)))

```

## 3.3 Slope and Graphic Design

### 3.3.1 Algebra Worksheet Application

This is an application of the Houston ISD Curriculum worksheet entitled, "Lets Change the Slope." The HISD algebra CLEAR curriculum can be found on the district website at [www.houstonisd.org](http://www.houstonisd.org).

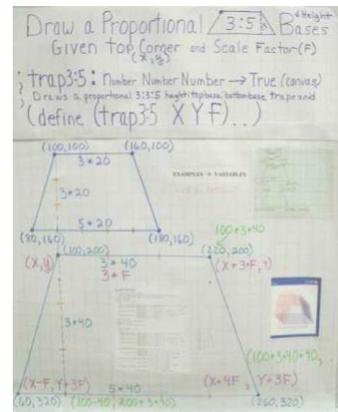
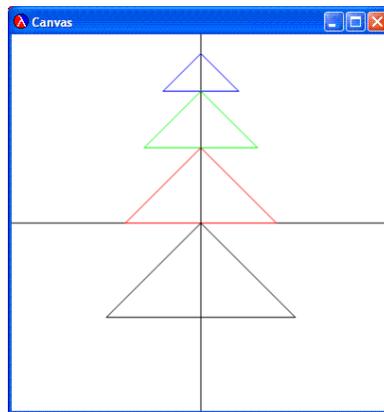
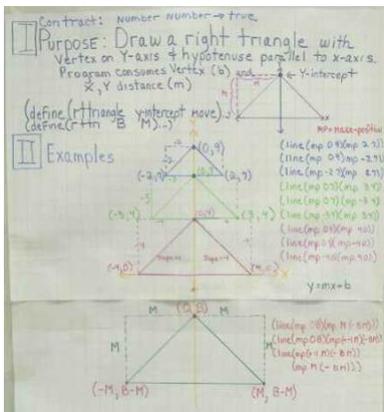
### 3.3.2 Directions

Write a function that draws a right triangle using the Cartesian Plane Code where:

- The hypotenuse is parallel to the x-axis
- The vertex where the sides intersect is on the y-axis.
- The vertex where the triangle begins on the Y-axis is an input variable.
- The length of each side is the same, creating an isosceles right triangle.
- The movement distance from the vertex to an end-point of the hypotenuse is an input variable.

### 3.3.3 Design Recipe

Students planned the graphic on graph paper plotting the points precisely. They then calculated the change in Y and the Change in X in order to get the ending points of each line. They wrote examples for these triangles and tested in Scheme to make sure they created a triangle per specifications given in the directions. They looked at patterns in the coordinate points and translated these to variable coordinate points. From that they wrote the variable expression for each line. Using that auxiliary function they created designs. Some students found patterns and used recursion to repeat the pattern.



**Trapezoid**

```
;; Trapezoid: N N N -> True
;; Draw a trapezoid using (x,y) coordinates and factor. This function can
also be used for dilatations.
(start 300 300)
(define (trapezoid x y f)
  (and
    (draw-solid-line (make-posn x y) (make-posn (+ (* 4 f) x) y) 'red)
    (draw-solid-line (make-posn (+ (* 4 f) x) y)
```

```

(make-posn (+ (* 5 f) x) (+ (* 4 f) y)) 'blue)
(draw-solid-line (make-posn (+ (* 5 f) x) (+ (* 4 f) y))
                 (make-posn (+ (* -1 f) x) (+ (* 4 f) y)) 'blue)
(draw-solid-line (make-posn (+ (* -1 f) x) (+ (* 4 f) y))
                 (make-posn x y) 'red))

```

### 3.4 Profit Program - Process Charts

#### 3.4.1 Developing Examples for the Design recipe

Data analysis and examples from the first two steps in the design recipe was applied continually throughout Algebra I to solve word problems. This is a visual guide for the profit program. Applications by students involved similar word problems for linear functions.

Students explained the process by demonstrating how they came up with their answer through application in a computer program. Each program required a process chart - examples to show how they developed the body of their function. The complete design recipe in color is available on my web page.

#### 3.4.2 Process Chart

	<u>Attendees</u>	<u>Profit</u>
Data Examples	10	$5 * 10 - (20 + .50 * 10) = 50 - 25 = 25$
Pick easy "head" data that has a pattern.	20	$5 * 20 - (20 + 50 * 20) = 100 - 30 = 70$
Continue the pattern	30	$5 * 30 - (20 + 50 * 30) = 150 - 35 = 115$
Variable	A	$5 * A - (20 + 50 * A) = P$
Combine Like Terms		$5A - 20 + 1/2A = P$
Slope-Intercept Form		$P = 9/2A - 20$

### 3.5 My Box Program – Physical Models

Students learned how to draw oblique, isometric and perspective sketches of a box prior to this project. Directions on drawing these sketches in *Paint* can be found on my web page on the TechSys / Introduction to Designing Graphics Link: <http://teachertech.rice.edu/Participants/knorth/TS/drawing.htm>. This module, along with the Introduction to Programming Graphics module, is part of my Technology Systems course. Extra credit was to design variable programs to draw boxes from different points-of-view.

#### 3.5.1. Physical Model Directions

- a. Take apart a box, measure each dimension, write an expression for the height and depths related to the width.
- b. Make a BOX where the width is the longest length, the height is a little more than 1/4 the length and the depth is a little less than 1/2 the length.
- c. Plan this first using plain paper.
- d. Label the variable size of all sides on your paper.
- e. Make your final box using card stock of 3 colors where each parallel side is the same color.



### 3.5.2 Auxiliary Functions

- Using the design recipe, write 3 auxiliary functions that will calculate the perimeter (in purpose, state what perimeter is being used – edges, ribbon around, etc.), surface area and volume of a box given the dimensions.
- Using the design recipe, write 3 auxiliary functions that will calculate the perimeter (use same purpose as in previous function), surface area and volume of a box given the width, the height scale factor and the depth scale factor. Reuse the above functions. Create a process chart developing a linear function for the perimeter, a quadratic function for the area and an exponential function for the volume.

### 3.5.3 Application for selling the box

Using the design recipe, write a function that will calculate the cost of producing your box given the cost of 1 square inch and number of boxes to be made.

## 4 Assessment

I have developed over 50 integrated algebra / computer science tests and practice quizzes located online at [www.quizlab.com](http://www.quizlab.com). I also have developed programming tests and concept tests. If you are interested in these, please contact me.

## 5. Student Comments on using the Design Recipe in Algebra

My ethnically mixed group of students shared that they found the design recipe helpful to determine, organize, and process data by providing a step-by-step skeleton to solve word problems and check answers. Details on their comments can be found in the appendix.

### The design recipe....

- ... helped me to have all the information that is necessary.
- ... helped me break down complex problems into smaller problems.
- ... helped to keep the problem organized and makes the data easier to read.
- ... helped to organize data so that none of it is forgotten.
- ... helped me write out all the data and draw a chart and helped me to find patterns.

... is a helpful skeleton that allows you to input your information so that solving a problem will be more organized.

... helped me see things in a step-by-step process and made me notice every little detail.

... helped me to understand the process more easily.

... required me to create examples with T-charts and process charts so I can see my example data clearly.

... helped because it had steps that were in a specific order.

... helped me to check my answers and find errors in my process.

... helped in such a way that no one was giving me the answer; it made me figure things out by myself and transformed me into an internal learner.

... helped me to actually think about what I was doing, instead of just "doing" and not thinking.

... helped with the answers that I could not get in my head.

... helped me in algebra by tying up loose ends; I started to get into a habit of breaking down problems without even knowing it..

... in HTDP put algebra into words and made it all come together.

... was used for just about every concept we covered in algebra.

... helped us practice the algebra concepts more.

... will help next year because I am going to try to use all the things we did in computer science to help me in Geometry.



## **A Appendices**

### **STUDENT COMMENT DETAILS**

#### **Westside High School, Houston ISD Algebra-Computer Science Combination Class 2004-2005**

##### Adriana

The design recipe really helped me because it helps you to have all the information that is necessary. It helps to maintain all your data organized because sometimes in algebra you get so many numbers, that you don't know which one is which. It helps you to know whether or not you were doing something right or wrong. The purpose and contract were so that you know what you have to do. The header enables you to understand what you are looking for. Then you get an answer and you test it with different examples. It is simple and organized.

The algebra concepts that we have gone over in Scheme using the design recipe are slope, linear equations, quadratic equations, arithmetic math, expressions, finding variables and much more. What we did for each was the basic design recipe to help us to truly comprehend the problem and then we tested them with different examples.

### Robbie

I used the design recipe in algebra to help me break down complex problems into smaller problems. I used the instructions as a "contract" and the actual problem as the "body." By breaking it down like this and trimming away the excess information, the problem becomes obvious and the solution is easier to find.

We learned income tax and probability by writing programs that simulated a random person's life by deciding his life with a dice simulator Scheme program and then we did the taxes.

### Lauren

The design recipe is very helpful when trying to solve algebraic problems. It helps to keep the problem organized and makes the data easier to read. The first step to the design recipe is the purpose. You must state the problem or question that you are trying to answer and the variables that will be used. You also state the dependent and independent variables in this step. The second step, examples, is where you list your data and try to locate patterns that might occur. Next the rules are stated in the third step. You write out the equation that will be used. Last you evaluate the equation with the independent variables that you listed in your example by filling the variables with test data and checking to make sure everything works out.

Design recipe can be used for many different algebraic problems, but a common use is for finding the slope of a line. There were many algebra concepts that we practiced in computer science this year. We covered things like proportion when we did the bulls-eye and proportion programs. Square roots and powers were practiced when we wrote programs to figure out square roots and power of different numbers. We covered geometry concepts such as surface area, perimeter, area, and volume when we wrote programs with formulas for different shapes. We made a 3-dimensional box and wrote a program for it. We covered conversions such as dollars-to-euros and Fahrenheit-to-Celsius. We covered quadratic functions by breaking them down and solving them and writing programs that returned true if the equation was correct. We also covered inequalities, equations, and word problems by creating programs in Scheme.

Scheme was a very big part of our algebra learning process this year. We used the design recipe for just about every concept we covered in algebra. This helped us practice the concepts more and play around with scheme functions.

### Juan

The design recipe assisted in many of my algebra struggles. The design recipe helped in such a way that no one was giving me the answer. It made me figure things out by myself and transformed me into an internal learner. The design recipe helped me see things in a step-by-step process and make me notice every little detail. The design recipe was very useful in figuring out algebra word problems and even algebraic equations. At first, the design recipe was a real drag and I never understood the purpose. However, when I began using it and all the steps that were in it, algebra became a little bit easier. The HTDP design recipe has been very useful throughout this school year and it is something that I will use in my future life when I am stuck.

### Sunnah

The design recipe helped because it helped with organization. When you use the design recipe and write out all your data and draw a chart, it helps you to find patterns and draw a graph. The design recipe helps you to understand the process more easily.

### Zehra

I used the design recipe in converting temperatures and different measurements. I came into this class because I did not know the basics of algebra. HTDP put algebra into words and made it all come together. DrScheme helped me get my negatives together because we did it so many times that I became comfortable. The order of the design recipe helped because it had steps that were in a specific order. When we started slope we set up a chart to find patterns. I came into this class with a little bit of algebra and I am leaving with both algebra and computer science.

### Tracy

I came to high school being an average math student. I was not good in math to begin with, so I wasn't going to be that good in computer science because most programs involved some kind of math. Computer science helped me in algebra because we would do programs with conversion, radicals, square roots and geometry. The HTDP design recipe helped because if I was not sure on an answer, I could just break it down into the recipe and try to work out the answer. So, next year I am going to try to use all the things we did in computer science to help me in geometry.

### Mickey

The HTDP design recipe helped me in algebra by tying up loose ends. I started to get into a habit of breaking down problems without even knowing it. I started thinking about what the problem was asking, what I was doing, and how it worked. The process helped me to dissect the problem and understand it more to get the proper answer.

### Brittanie

The design recipe is a helpful skeleton that allows you to input your information so that solving a problem will be more organized. This year I used the design recipe mostly for word problems, especially ones involving linear functions. Using the steps of the recipe, I sorted the problem into the process I would need to solve it. I write down the problem in the purpose/Quadrant I section of the 4-corner plan and list my dependent and independent variables. Inside Quadrant II, the example section, I made data tables or T-charts to see patterns and relationships. In Quadrant III or body section I wrote the function to see if it correctly matched the variables. I worked out the answer using the examples, which is basically Quadrant IV, or the test section. I also graphed the function in this section to check, sometimes using the graphing calculator.

### David

First I figure out how the process of my problem is going to work out. After I have found the process I created examples with T-charts and process charts so I can see my example data clearly. Then I used the process I did first to figure out a formula that I used to get the appropriate answer for the problem that I was given. Once I have the formula I can test out my solution by putting in the data that I used in the example section to see if the answer is correct or if I have any errors.

### Cara

I used the design recipe in algebra to help break problems down step by step so that I could see how to work them out and make better sense for me. It helped me to actually think about what I was doing, instead of just "doing" and not thinking.

### Wesley

I used the design recipe to organize data so that none of it was forgotten. It helped me to check my answers and find errors in my process. We practiced arithmetic expressions and learned how to program them into DrScheme. We drew pictures and used algebra to make everything proportional. We programmed quadratic and linear equations.

### Cynthia

You have to go through different stages to have your data correctly organized so you get the right answer. You have to understand the constants, independent and dependent variables in the problem. The design recipe helps you go in order.

### Evin

I used the design recipe to help with the answers that I could not get in my head. I had never used DrScheme before and it was very confusing at first, but then I started getting the hang of it after we learned how to do a design recipe. I learned that I could put it in the design recipe and understand the problem much better. I learned things I never thought I would be able to understand before, such as the way you write the contract, you can use that name again in the header, instead of thinking of a different name. Now I use this process in other classes. I use it in science when we have a lab. I use it in golf to calculate the distance. Without the design recipe, I might be failing other classes.

### James

I didn't use the design recipe very much because I could do most of the problems in my head. The recipe slowed me down and made it harder for me to figure out the problem. I found out that using my brain rather than the recipe was easier.

### Adam

Learning algebra using computers has had a major effect on my learning experience. I have learned many things in algebra this year including basic formulas, graphing equations, substitutions, systems of equations, parabolas, linear and quadratic equations. I think I have learned more in math class this year as a freshman than any other year because it was taught using computers, which is something I can relate to. By combining algebra and computer science I learned how to create webpages and I refer to the size of my monitor as a 4:3 ratio. I think the only major concepts I mastered before 9<sup>th</sup> grade were addition, subtraction, multiplication, division and some fractions. I knew very little about how to calculate percents, divide and multiply fractions and decimals without using a calculator.

### Gabby

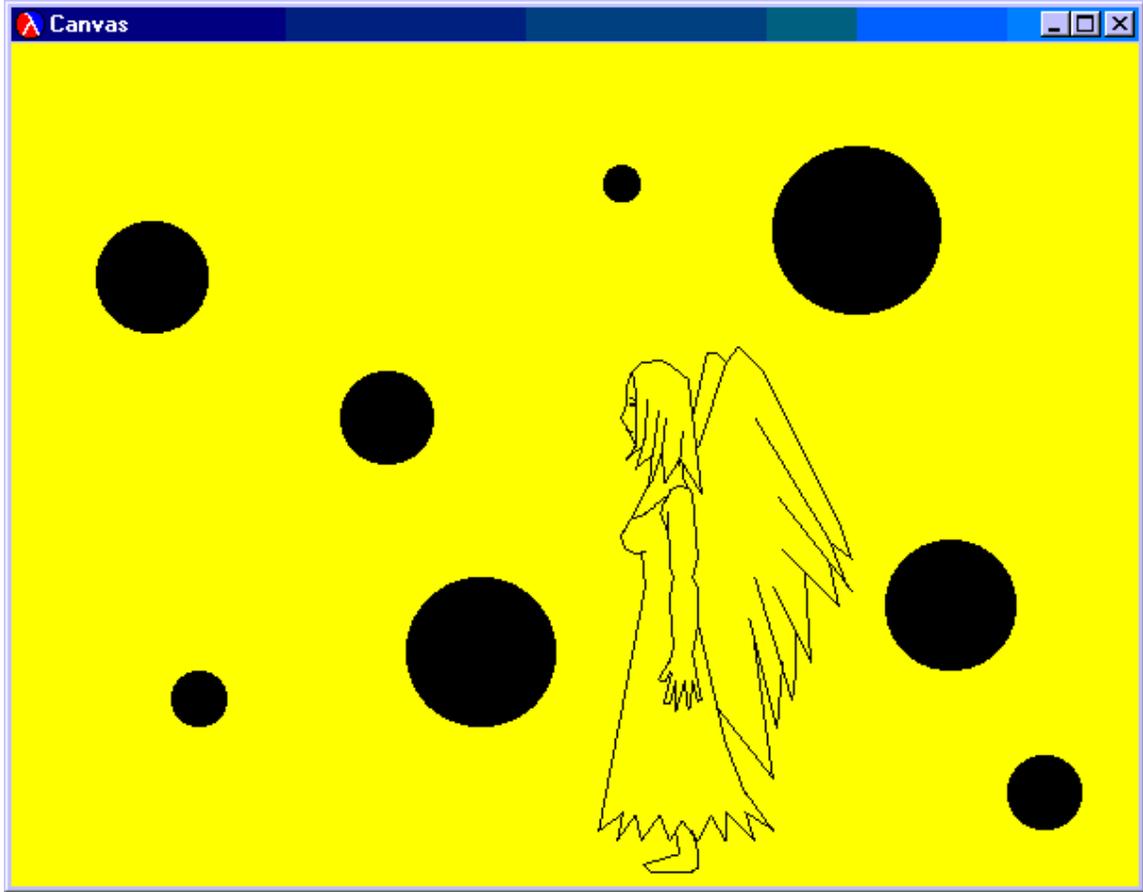
The design recipe was used in algebra a lot because we had to have a purpose for what we were doing, examples to help the process be understood, a body which was the actual process and a test where we test the function or process with data. We used variables for everything as well as the design recipe in order to find a solution for any given problem.

### Laura

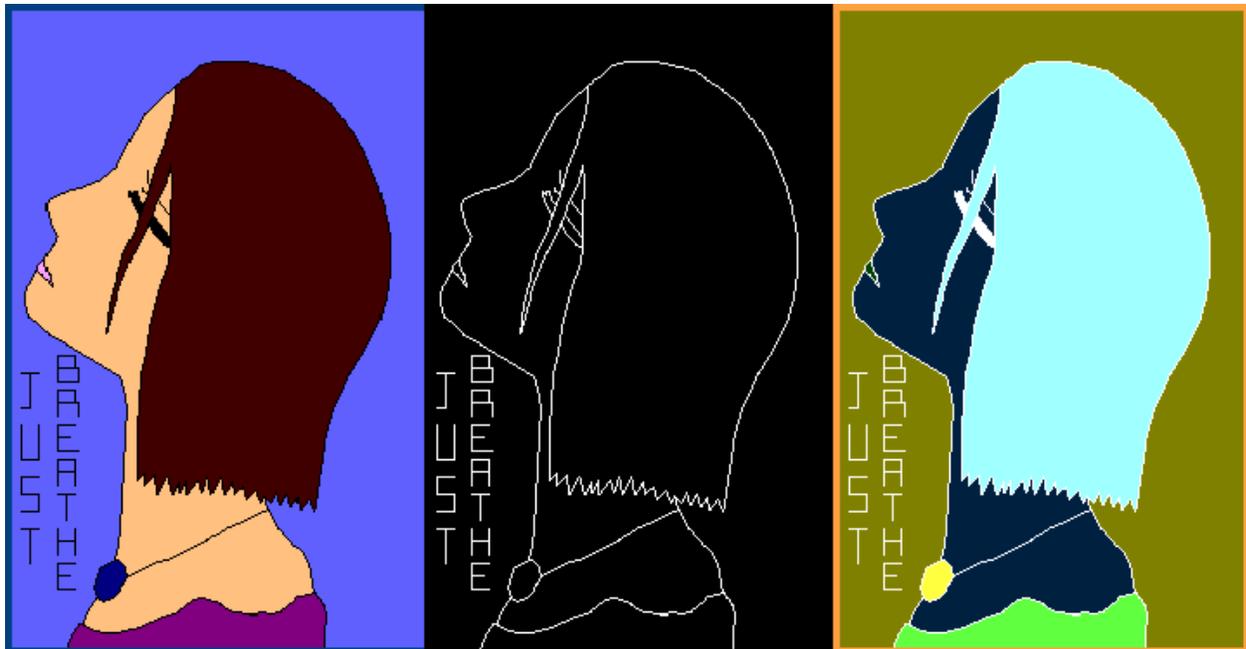
I used the design recipe to take a step by step approach on difficult problems.

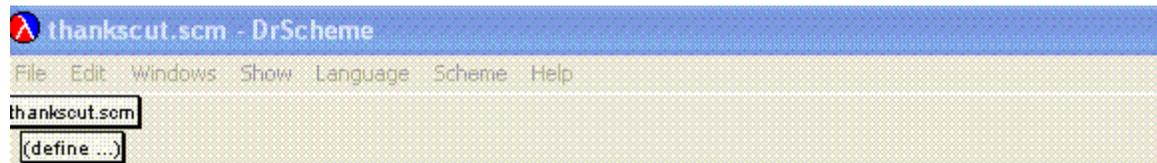
Note: Laura struggled all year in both algebra and CS. She was an artist who created the following graphic examples entitled *Fallen Angel*, *Just Breathe*, and *Thanks*. The light bulb finally went off at the end of the year. As I watched her sitting cross-legged with her graph paper in hand planning her last graphic in May, I knew this experiment was a success. I am finally getting students to think and plan before coding! And that same thinking and planning is carried over to solving word problems. After failing the first semester of algebra, Laura passed a test-by-exam to receive credit. And not only did Laura pass the Texas math accountability test, she received commended on TAKS.

**“Fallen Angel” All Created with Scheme Code.**



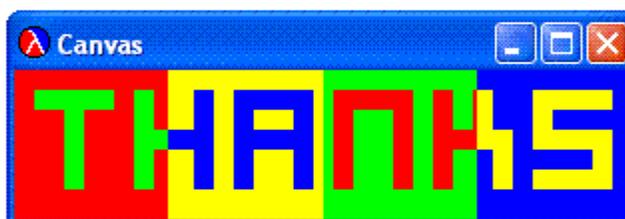
“Just Breathe” - 2 views edited in *Paint* to add colors.





Thanks Designed by Laura Nance, May 2005

```
(start 310 75)
;;---- Background ----
(draw-solid-rect (make-posn 0 0) 310 190 'blue)
(draw-solid-rect (make-posn 0 0) 232 190 'green)
(draw-solid-rect (make-posn 0 0) 155 190 'yellow)
(draw-solid-rect (make-posn 0 0) 77 190 'red)
;;---- T ----
(draw-solid-rect (make-posn 10 10) 40 10 'green)
(draw-solid-rect (make-posn 25 20) 10 40 'green)
;;---- H ----
(draw-solid-rect (make-posn 60 10) 10 50 'green)
(draw-solid-rect (make-posn 70 30) 7 10 'green)
(draw-solid-rect (make-posn 77 30) 13 10 'blue)
(draw-solid-rect (make-posn 90 10) 10 50 'blue)
;;---- A ----
(draw-solid-rect (make-posn 110 10) 40 10 'blue)
(draw-solid-rect (make-posn 110 10) 10 50 'blue)
(draw-solid-rect (make-posn 140 10) 10 50 'blue)
(draw-solid-rect (make-posn 120 30) 20 10 'blue)
;;---- N ----
(draw-solid-rect (make-posn 160 10) 40 10 'red)
(draw-solid-rect (make-posn 160 10) 10 50 'red)
(draw-solid-rect (make-posn 190 10) 10 50 'red)
;;---- K ----
(draw-solid-rect (make-posn 210 10) 10 50 'red)
(draw-solid-rect (make-posn 220 30) 12 10 'red)
(draw-solid-rect (make-posn 230 10) 2 20 'red)
(draw-solid-rect (make-posn 232 10) 8 30 'yellow)
(draw-solid-rect (make-posn 240 30) 10 30 'yellow)
;;---- S ----
(draw-solid-rect (make-posn 260 10) 40 10 'yellow)
(draw-solid-rect (make-posn 260 10) 10 30 'yellow)
(draw-solid-rect (make-posn 270 30) 30 10 'yellow)
(draw-solid-rect (make-posn 290 40) 10 20 'yellow)
(draw-solid-rect (make-posn 260 50) 30 10 'yellow)
```



I would like to add Thanks to Dr. Felleisen for his support of my Houston A+ Grant and encouragement. Without his continually motivation in the use of DrScheme and HTDP, I would not have been able to develop these materials. I would also like to add thanks to Dr. Krishnamurithi as well as Dr. Felleisen for their assistance in editing all my published papers. It has been a tremendous experience working with the PLT over the last 10 years. They have changed the way I teach. I greatly appreciate all their suggestions for the improvement of computer science education in the world. I thank the entire TeachScheme! Team for their tremendous contribution to the education of computer science teachers.