

Coding in the Classroom for Comprehension And Contextual Learning

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Why Teach Kids to Program in a Math Class?

- Some ideas in mathematics are routines/procedures
- Sometimes kids are taught to rotely memorize these procedures and they quickly forget them
- Conceptual understanding of the ideas leads to the ability to remember longer
- Being able to break down the steps of the procedure into a programming language can lead to that conceptual understanding

What procedures might you choose from Algebra, PreCalculus and Calculus

- Systems of Linear Equations (two equations and two unknowns)
- Quadratics
 - Completing the Square/Quadratic Formula
 - Vertex of form of a Parabola
- Slope of a Secant Line/Difference Quotient (as the points grow closer)
- Polynomials
 - End Behavior/Limits at infinity
 - Asymptotes/Limits at a
- Lines
 - Slope, y-intercept, and x-intercept given a line in standard form
 - The slope and equation of a line given two points
 - The equation of a line given a point and slope

Enhance student understanding

[CCSS.Math.Content.HSF.IF.C.7.a](#)

Graph linear and quadratic functions and show intercepts, maxima, and minima.

[CCSS.Math.Content.HSF.IF.C.7.c](#)

Graph polynomial functions, identifying zeros when suitable factorizations are available, and showing end behavior.

[CCSS.Math.Content.HSF.IF.C.7.d](#)

(+) Graph rational functions, identifying zeros and asymptotes when suitable factorizations are available, and showing end behavior.

[CCSS.Math.Content.HSF.IF.C.7.e](#)

Graph exponential and logarithmic functions, showing intercepts and end behavior, and trigonometric functions, showing period, midline, and amplitude.

Systems of Linear Equations (2 equations and 2 unknowns)

$$2x + y = 15$$

$$3x - y = 5$$

Systems of Linear Equations (2 equations and 2 unknowns)

$$\begin{array}{rcl} \begin{bmatrix} 2x+y=15 \end{bmatrix} \times 3 & & \begin{bmatrix} 2x+y=15 \end{bmatrix} \times -1 \\ \begin{bmatrix} 3x-y=5 \end{bmatrix} \times -2 & & \begin{bmatrix} 3x-y=5 \end{bmatrix} \times -1 \\ \hline 6x+3y=45 & & -2x-y=-15 \\ -6x+2y=-10 & & -3x+y=-5 \\ \hline 5y=35 & & -5x=-20 \\ y=7 & & x=4 \end{array}$$

$$\begin{array}{rcl} [Ax+By=C] \times D & & [Ax+By=C] \times E \\ [Dx+Ey=F] \times -A & & [Dx+Ey=F] \times -B \\ \hline y = (CD-AE)/(BD-AE) & & x = (CE-BF)/(AE-BD) \end{array}$$

Systems of Linear Equations (2 equations and 2 unknowns)

```
NORMAL FLOAT AUTO REAL DEGREE CL
EDIT MENU: [alpha] [f5]
PROGRAM:ELIM2
:ClrHome
:Prompt A,B,C,D,E,F
: (CD-AF)/(BD-AE)→Y
: (CE-BF)/(AE-BD)→X
:Disp "(X,Y)"
:Disp X▶Frac,Y▶Frac
:
```


Solving by Completing the Square/ The Quadratic Formula

Solve by Completing the Square

$$2x^2 + 3x + 1 = 0$$
$$2x^2 + 3x = -1$$
$$x^2 + \frac{3}{2}x + \frac{9}{4} = -\frac{1}{2} + \frac{9}{4}$$
$$\left(x + \frac{3}{2}\right)^2 = -\frac{2}{4} + \frac{9}{4}$$
$$\sqrt{\left(x + \frac{3}{2}\right)^2} = \pm \sqrt{\frac{7}{4}}$$
$$x + \frac{3}{2} = \pm \sqrt{\frac{7}{4}}$$
$$x = -\frac{3}{2} \pm \frac{\sqrt{7}}{2}$$
$$x = \frac{-3 \pm \sqrt{7}}{2}$$

$\left(\frac{3}{2}\right)^2$
 $= \frac{9}{4}$

Quadratic Formula

$$ax^2 + bx + c = 0$$
$$x^2 + \frac{b}{a}x + \frac{c}{a} = 0$$
$$x^2 + \frac{b}{a}x = -\frac{c}{a}$$
$$x^2 + \frac{b}{a}x + \frac{b^2}{4a^2} = -\frac{c}{a} + \frac{b^2}{4a^2}$$
$$\left(x + \frac{b}{2a}\right)^2 = \frac{-4ac}{4a^2} + \frac{b^2}{4a^2}$$
$$\left(x + \frac{b}{2a}\right)^2 = \frac{b^2 - 4ac}{4a^2}$$
$$\sqrt{\left(x + \frac{b}{2a}\right)^2} = \pm \sqrt{\frac{b^2 - 4ac}{4a^2}}$$
$$x + \frac{b}{2a} = \pm \frac{\sqrt{b^2 - 4ac}}{2a}$$
$$x = -\frac{b}{2a} \pm \frac{\sqrt{b^2 - 4ac}}{2a}$$
$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

$\left(\frac{b}{a} \cdot \frac{1}{2}\right)^2$
 $= \left(\frac{b}{2a}\right)^2$
 $= \frac{b^2}{4a^2}$

Quadratic Formula Program

```
NORMAL FLOAT AUTO REAL DEGREE CL
EDIT MENU: [alpha] [f5]
PROGRAM: QUADFORM
: Prompt A, B, C
: ( -B + sqrt(B^2 - 4AC) ) / (2A) -> M
: ( -B - sqrt(B^2 - 4AC) ) / (2A) -> N
: Disp M, N
:
```

vertex form of a Parabola

$$\begin{aligned}y &= 3x^2 + 12x + 5 \\y &= 3(x^2 + 4x) + 5 \\y &= 3(x^2 + 4x + 4) + 5 - 12 \\y &= 3(x + 2)^2 - 7\end{aligned}$$

$$\begin{aligned}y &= ax^2 + bx + c \\y &= a\left(x^2 + \frac{b}{a}x\right) + c \\y &= a\left(x^2 + \frac{b}{a}x + \frac{b^2}{4a^2}\right) + c - \frac{b^2}{4a} \\y &= a\left(x + \frac{b}{2a}\right)^2 + \frac{-b^2 + 4ac}{4a}\end{aligned}$$

Vertex of a Parabola Program

```
NORMAL FLOAT AUTO REAL DEGREE CL
EDIT MENU: [alpha] [f5]

PROGRAM: VERTEX
: Prompt A,B,C
: -B/(2A)→H
: (-B²+4AC)/(4A)→K
: Disp H,K
:
```

Difference Quotient/ Derivatives

NORMAL FLOAT AUTO REAL DEGREE CL
EDIT MENU: [alpha] [f5]

PROGRAM: SECTBL

: Prompt A, B

: (Y1(A) - Y1(B)) / (A - B) → M

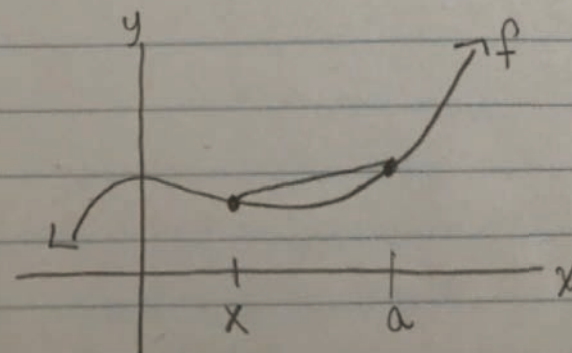
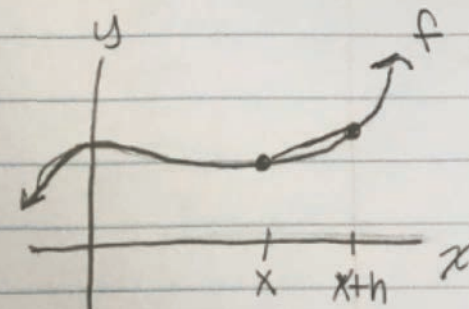
: Disp M

:

$$\lim_{h \rightarrow 0} \frac{f(x+h) - f(x)}{h}$$

OR

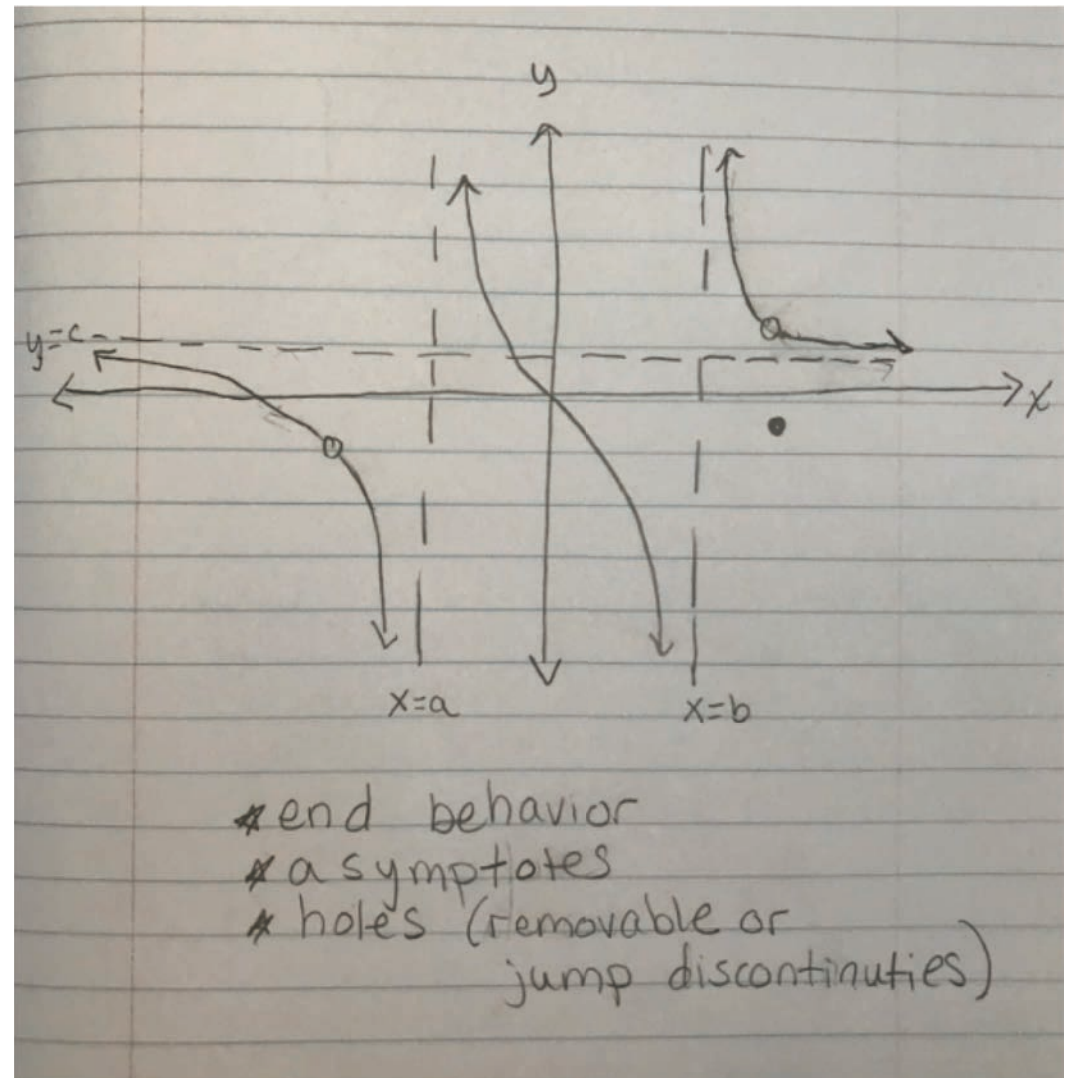
$$\lim_{x \rightarrow a} \frac{f(x) - f(a)}{x - a}$$



Scrutinizing Functions

```
NORMAL FLOAT AUTO REAL RADIANT MP
PROGRAM: NEARA
: Prompt A
: {A+.1, A+.01, A+.001, A+.0001, A+.00001, A-.1, A-.01, A-.001, A-.0001, A-.00001} → L1
: Y1(L1) → L2

NORMAL FLOAT AUTO REAL RADIANT MP
PROGRAM: ENDBEHAV
: {10, 100, 1000, 10000, 100000, 1000000} → L3
: Y1(L3) → L4
: -L3 → L5
: Y1(L5) → L6
```



Applying student understanding

Airpact Impact Study

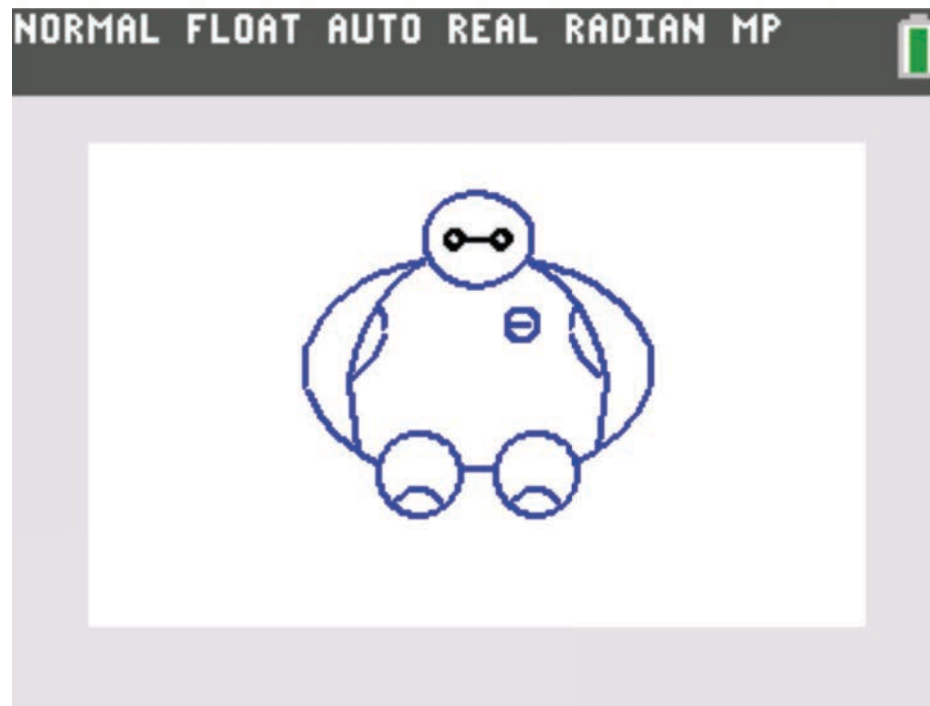
Blood Alcohol Content


```

Input "INDEPENDENT LIST IN { }",L1
Input "DEPENDENT LIST IN { }",L2
Disp "X*Y="
L1*L2→L4
Pause L4
L12→L3
Disp "X2*Y="
L2*L3→L4
Pause L4
Disp " "
Disp "IS Y INVERSELY RELATED TO"
Disp "X OR X2?"
Pause
Input "WHAT IS K?",K
Input "TYPE WITH QUOTES Y1=",Y1
Input "Y-VALUE",I
K/I→E
Disp "X-VAL IF INVERSELY TO X"
Disp E
√(K/I)→D
Disp "X-VAL IF INVERSELY TO X2"
Disp D

```

Check student understanding



#2



$$\left(\frac{x^2}{3.5} + \frac{(y-5)^2}{2.5} = 1 \right) \cdot \frac{1}{10}$$

$$\frac{x^2}{35} + \frac{(y-5)^2}{25} = \frac{1}{10}$$

$$\frac{x^2}{35} + \frac{(y-5)^2}{25} = \frac{1}{10}$$

$$\frac{(y-5)^2}{25} - \frac{(y-5)^2}{25} = \frac{9}{10}$$

$$\frac{(y-5)^2}{15} = \frac{9}{10} + \frac{(y-5)^2}{25}$$

$$\frac{(y-5)^2}{15} = \frac{22.5 + (y-5)^2}{25}$$

$$25(y-5)^2 = 15(22.5 + (y-5)^2)$$

$$25(y^2 - 10y + 25) = 15(22.5 + y^2 - 10y + 25)$$

$$25y^2 - 30y + 9 = 337.5 + 15y^2 - 150y + 375$$

$$10y^2 + 120y - 703.5 = 0$$

$$y = \frac{-120 \pm \sqrt{(120)^2 - 4 \cdot 10 \cdot -703.5}}{2 \cdot 10}$$

$$y = \frac{-120 \pm \sqrt{42540}}{20}$$

$$y \approx 4.31 \quad y \approx -16.31$$

$$\frac{x^2}{3.5} = 1 - \frac{(y-5)^2}{2.5}$$

$$\frac{x^2}{3.5} = \frac{2.5 - (y-5)^2}{2.5}$$

$$x^2 = \frac{3.5(2.5 - (y-5)^2)}{2.5}$$

$$x^2 = \frac{8.75 - 3.5(y-5)^2}{2.5}$$

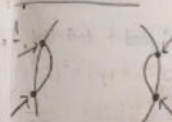
$$x^2 = \frac{8.75 - 3.5(4.31-5)^2}{2.5}$$

$$x^2 \approx 2.83$$

$$x \approx \pm 1.68$$

$$\boxed{(1.68, 4.31)} \\ \boxed{(-1.68, 4.31)}$$

Intersections



$$\frac{x^2}{20} + \frac{(y+0.8)^2}{30} = 1$$

$$\frac{x^2}{10} - \frac{(y-2)^2}{4} = 1 \quad \cdot \frac{1}{2}$$

$$\frac{x^2}{20} - \frac{(y-2)^2}{8} = \frac{1}{2}$$

$$\frac{x^2}{20} + \frac{(y+0.8)^2}{30} = 1$$

$$-\frac{(y-2)^2}{8} - \frac{(y+0.8)^2}{30} = -\frac{1}{2}$$

$$-\frac{(y^2 - 4y + 4)}{8} = -\frac{1}{2} + \frac{(y^2 + 1.6y + 0.64)}{30}$$

$$-\frac{y^2 - 4y - 4}{8} = \frac{-15 + y^2 + 1.6y + 0.64}{30}$$

$$-\frac{y^2 - 4y - 4}{8} = \frac{y^2 + 1.6y - 14.36}{30}$$

$$30(-y^2 + 4y - 4) = 8(y^2 + 1.6y - 14.36)$$

$$-30y^2 + 120y - 120 = 8y^2 + 12.8y - 114.88$$

$$-38y^2 + 107.2y - 5.12 = 0$$

$$y = \frac{-107.2 \pm \sqrt{(107.2)^2 - 4 \cdot -38 \cdot -5.12}}{2 \cdot -38}$$

$$y = \frac{-107.2 \pm \sqrt{10113.6}}{-76}$$

$$y \approx 0.05 \quad y \approx 2.77$$

$$\frac{x^2}{10} = 1 - \frac{(y-2)^2}{4}$$

$$\frac{x^2}{10} = \frac{4 - (y-2)^2}{4}$$

$$x^2 = \frac{10(4 - (y-2)^2)}{4}$$

$$x^2 = \frac{20 + 5(y-2)^2}{2}$$

$$x^2 = \frac{20 + 5(0.05-2)^2}{2}$$

$$x^2 \approx 19.52$$

$$x \approx \pm 4.42$$

$$x^2 = \frac{20 + 5(2.77-2)^2}{2}$$

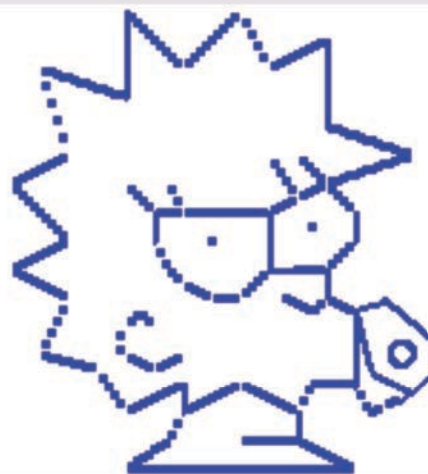
$$x^2 \approx 11.49$$

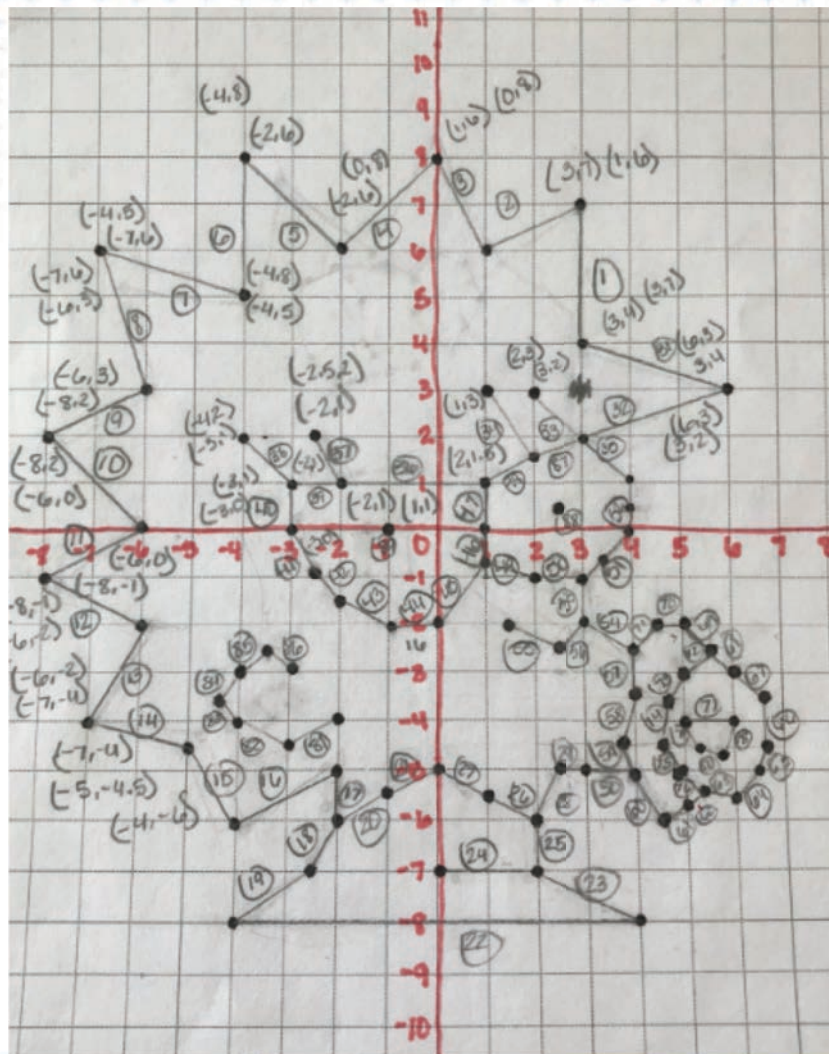
$$x \approx \pm 3.39$$

$$\boxed{(3.39, 2.77)} \\ \boxed{(-3.39, 2.77)} \\ \boxed{(4.42, 0.05)} \\ \boxed{(-4.42, 0.05)}$$



NORMAL FLOAT AUTO REAL RADIANT MP





① $(3,4) (3,7)$ $\frac{7-4}{3-3} = \frac{3}{0}$ $x=3 \{4 < y < 7\}$
 $y=mx+b$

② $(1,6) (3,7)$ $\frac{7-6}{3-1} = \frac{1}{2}$ $7 = \frac{1}{2}(3) + b$
 $y=mx+b$ $7 = 1\frac{1}{2} + b$
 $y = \frac{1}{2}x + 6\frac{1}{2}$ $-1\frac{1}{2} -1\frac{1}{2}$
 $\{1 < x < 3\}$ $5\frac{1}{2} = b$

③ $(1,6) (0,8)$ $\frac{8-6}{0-1} = \frac{2}{-1} = -2$ $6 = -2(1) + b$
 $y=mx+b$ $6 = -2 + b$
 $y = -2x + 8$ $+2 +2$
 $\{0 < x < 1\}$ $8 = b$

④ $(-2,6) (0,8)$ $\frac{8-6}{0-(-2)} = \frac{2}{2} = 1$ $6 = 1(-2) + b$
 $y=mx+b$ $6 = -2 + b$
 $y = 1x + 8$ $+2 +2$
 $\{-2 < x < 0\}$ $8 = b$

⑤ $(-2,6) (-4,8)$ $\frac{8-6}{-4-(-2)} = \frac{2}{-2} = -1$ $8 = -1(-4) + b$
 $y=mx+b$ $8 = 4 + b$
 $y = -1x + 4$ $-4 -4$
 $\{-4 < x < -2\}$ $4 = b$

⑥ $(-4,5) (-4,8)$ $\frac{8-5}{-4-(-4)} = \frac{3}{0}$ $x=-4 \{5 < y < 8\}$
 $y=mx+b$

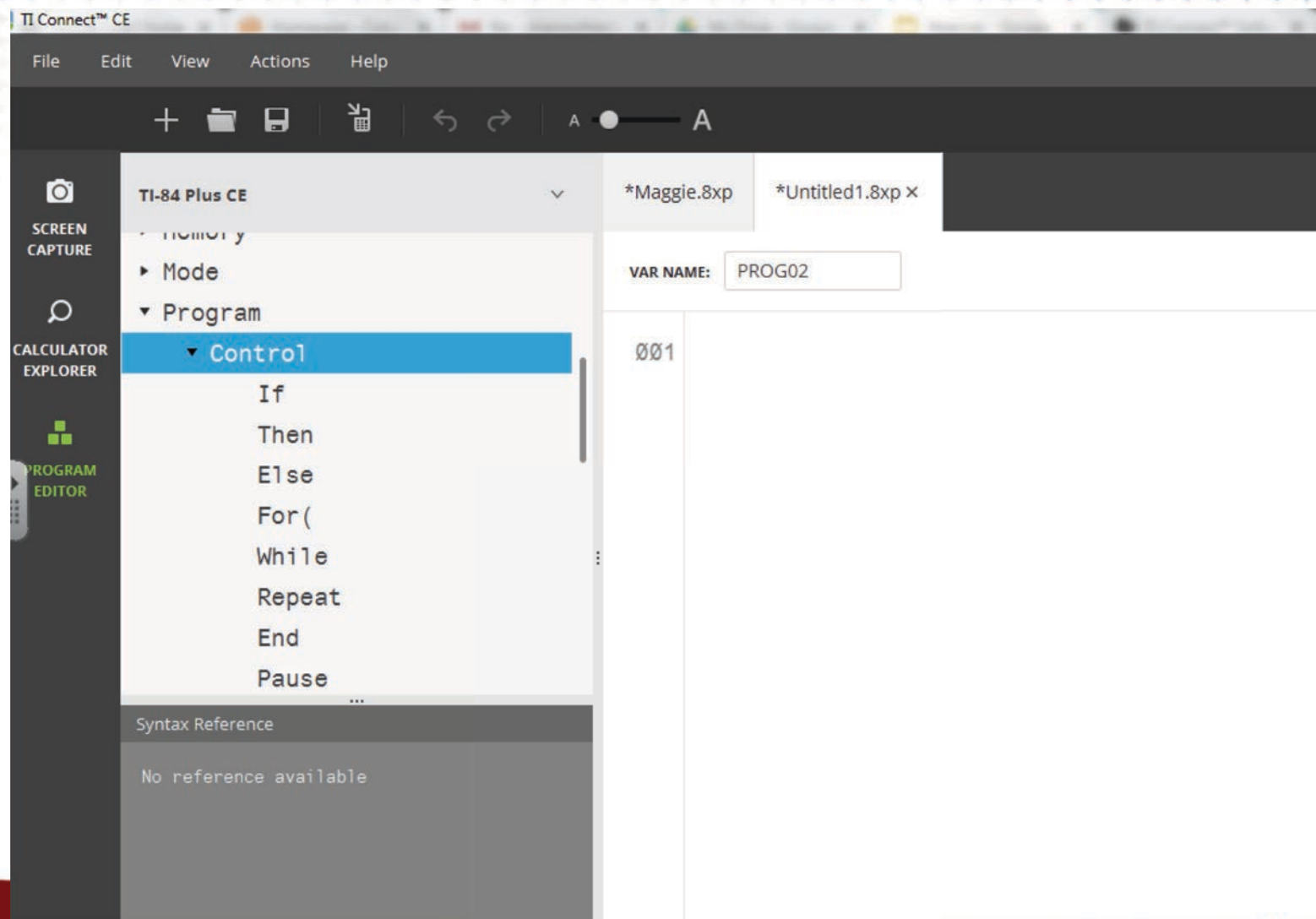
TI Connect™ Software

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Maggie (part 1)

```
ØØ1  ClrDraw:GridOff
ØØ2  AxesOff:Radian:DetectAsymOff
ØØ3  BackgroundOff
ØØ4  PlotsOff
ØØ5  -6.6*2→Xmin:6.6*2→Xmax
ØØ6  -4.1*2→Ymin:4.1*2→Ymax
ØØ7  For(A,Ø,9)
ØØ8  GraphStyle(A,7)
ØØ9  GraphColor(A,1Ø)
Ø1Ø  End
Ø11  "piecewise(.5X+5.5,1<X<3,-2X+8,Ø<X<1,X+8,-2<X<Ø,-X+4,-4<X<-2,(-1/3)X+(3+2/3
Ø12  "piecewise(-3X-15,-7<X<-6,-1.5X-12,-5<X<-4,.5X-4,-4<X<-2)"→Y2
Ø13  "piecewise(.5X+6,-8<X<-6,2X-2,-2.5<X<-2,(2/3)X-(5+1/3),-4<X<-2.5,-.5X-6,2<X
Ø14  "piecewise(-X-6,-8<X<-6,.5X-5,-2<X<Ø,-.5X-5,Ø<X<2,2X-1Ø,2<X<2.5,-5,2.5<X<4)
Ø15  "piecewise(.5X+3,-8<X<-6,(-1/3)X+5,3<X<6,-X+5,2<X<3,-1.5X+4.5,1<X<2,1,-2<X<
Ø16  "piecewise(-.5X-5,-8<X<-6,-8,-4<X<4,-2X+3,4<X<4.5,.4X-7.8,4.5<X<5,.6X-8.8,5
Ø17  "piecewise(2X+1Ø,-7<X<-6,(1/3)X+1,3<X<6,-2X-3,-2.5<X<-2,-X-2,-4<X<-3,-2,-1<
Ø18  "piecewise(-.25X-5.75,-7<X<-5,-X+5,3<X<4,1,-3<X<-2,-.5X-2.5,-2<X<-1,X-2,Ø<X
Ø19  "piecewise(-2X-6,-3<X<-2.5,-X-3.5,-2.5<X<-2,.5X+.5,1<X<2,-1,1<X<3,X-4,3<X<4
Ø2Ø  "piecewise(-.5X-.5,3<X<4,-.5X-1.25,1.5<X<2.5,X-5,2.5<X<3,5X-23.5,3.8<X<4)"→
Ø21  DispGraph
Ø22  StorePic 1
```

```

"piecewise(-2.5X+5,3.8<X<4)"→Y1
"piecewise(.5X-3,-3<X<-2)"→Y2
"piecewise(X+8,-2<X<0)"→Y3
"piecewise(1.5X+3,-4.4<X<-4,X+1,-4<X<-3.5,-X-6,-3.5<X<-3)"→Y4
"piecewise(-.5X-6,-4<X<-3,-X-8,-4.4<X<-4,.5X+.5,2<X<3)"→Y5
RecallPic 1
Pt-On(2.5,0.5)
Pt-On(-1,0)
Line(3,4,3,7)
Line(-4,5,-4,8)
Line(-2,-6,-2,-5)
Line(2,-7,2,-6)
Line(-3,0,-3,1)
Line(1,-1,1,1)
Line(4,0,4,1)
Line(3,-1,3,-2)
Line(4,-2.5,4,-3.5)
Line(6.8,-3.5,6.8,-4.5)
Line(1,-1,2,-1)
Line(4,-2.4,5,-2.1)
Line(5.6,-5.6,6.8,-4.6)
Line(4.6,-4.6,5.9,-5.3)
Circle(5.6,-3.9,.4)
Line(4,-2.5,4.5,-4.5)
Line(5,-2,6.8,-3.5)

```

Maggie (part 2)

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- Some ideas in mathematics are routines/procedures
- Sometimes kids are taught to rote memorize these procedures and they quickly forget them
- Conceptual understanding of the ideas leads to the ability to remember longer
- Being able to break down the steps of the procedure into a programming language can lead to that conceptual understanding

**Thanks for attending.
If you ever need help, don't
hesitate to contact us.**

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