Learning & Success in Algebra
Research Summary
November 2015

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CONTEXT Over half of community college students are required to take pre-college math. Students placed into remediation are less likely to complete a degree or certificate. Many never attempt a college-level mathematics course. As part of a broader effort to increase student success, many colleges have begun to rethink their remediation programs.

These efforts have created a growing body of research using standard measures of success such as grades, pass rates, retention, and completion. However, higher education is intended to prepare students for work and life. Thus, student success includes more than staying in college or completion. There is insufficient research on the skills that students learn and scant reflection on how remediation prepares them for their intended paths. This study aims to partially fill that gap. It examines the relationship between traditional student success measures and students' mathematical knowledge. A clearer understanding of the relationship between learning and course success will support continued efforts at reform.

This study follows a cohort of students at a community college implementing developmental math reforms. The math department had created an innovative two-quarter remedial sequence as an alternative to the pre-existing three-quarter algebra sequence (the same learning outcomes). In addition, they created an alternative intermediate algebra course that was concept-based and contextualized.

DESIGN In Winter 2012, all intermediate algebra students were given an assessment of algebra skills at the beginning of the quarter. An identical assessment was given at the beginning of the following quarter in all college level math classes with intermediate algebra as a prerequisite. The students' long-term outcomes were followed for three and a half years. The assessment consisted of three parts: (i) a set of mostly procedural algebra items which asked students to “solve” or “simplify” from the college's final exams for intermediate algebra, (ii) a set of items from the MARS Balanced Assessment in Mathematics which focuses on conceptual problem solving and explanation, and (iii) a survey of student attitudes and personal characteristics.

RESULTS

- Taking a quarter off of math was associated with much lower procedural math scores, but not conceptual/contextualized math scores.
- There was no consistent relationship between student grades in intermediate algebra and their algebra skills as measured by the assessment.
- Students’ procedural algebra skills as measured by the procedural items did not predict performance in college level classes after controlling for previous grades.
- Students who were able to more successfully do algebra problems were no more likely to graduate than other students.

CONCLUSIONS These finding suggest that remedial math sequences should be focused on conceptual understanding & contextualized skills in order to help students retain mathematical knowledge. It seems that students forget procedural algebra within a few months. They also suggest that taking intermediate algebra is not necessary for students who do not plan on taking college algebra. In addition, these results cast doubt on the assumption that grades reflect the amount that student learn. As this relationship is likely influenced by local factors, more research should be done at individual colleges to ensure that grades are strongly tied to student learning.
Record Your Thoughts: What policy changes and shifts in teaching and learning practices would you want to see on your campus based on these findings (assuming that the findings are accurate and generalizable across all student populations).

Take Action: What action (if any) will you take based on what you’ve learned?
“Learning from Research” – Your Hypotheses
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November 2015                                                                                                                     cquarles@everettcc.edu micdavis@berkeley.edu

1) Does decreasing the number of required developmental classes (acceleration) affect the amount students learn?

2) Is conceptual/contextual math retained longer than procedural algebra?

3) Which predicts success in college level math better:
   - A student’s procedural math skills on the first day of class, or
   - Their conceptual/contextual math skills on the first day of class?

4) How much does a student’s grade in intermediate algebra reflect:
   - The skills learned during the course,
   - The skills they knew at the end of the course, or
   - Their demographics and personal characteristics?
Math 81/82/99 - 3-quarter traditional procedural algebra sequence
Math 91/92 - Same as 81/82/99, without direct repetition
Math 98 - Integrated communication, data, and real-world applications with procedural algebra topics

Everett Community College
Developmental Math, circa 2011

<table>
<thead>
<tr>
<th>Variables Relating to Algebra Skills</th>
<th>Possible Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>ph3_EvCCaverage</td>
<td>Score on Phase 3 EvCC items</td>
</tr>
<tr>
<td>evccgains</td>
<td>Improvement from Phase 1 to Phase 3 on EvCC items</td>
</tr>
<tr>
<td>contextscores1XX</td>
<td>Score on conceptual/contextual items</td>
</tr>
<tr>
<td>algoscores1XX</td>
<td>Score on procedural algebra items</td>
</tr>
<tr>
<td>ph3_92score</td>
<td>Score on a subscale of items corresponding to Math 92 content</td>
</tr>
<tr>
<td>gains92</td>
<td>Improvement from Phase 1 to Phase 3 on the Math 92 subscale</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Grades</th>
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</thead>
<tbody>
<tr>
<td>ph3_D8r</td>
<td>Self-reported grade in previous 2-3 math classes</td>
</tr>
<tr>
<td>gradesin9X</td>
<td>Grade in intermediate algebra during the quarter of Phase 1</td>
</tr>
<tr>
<td>gradesin1XX</td>
<td>Grade in intro college math during the quarter of Phase 3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Demographic Variables</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>age</td>
<td>15 to 65</td>
</tr>
<tr>
<td>math_last_qtr1XX</td>
<td>Did the student take a math class in the past 3 months</td>
</tr>
<tr>
<td>PELL_ELIG</td>
<td>Eligibility for Pell Grant – a measure of poverty</td>
</tr>
<tr>
<td>SEX</td>
<td>1 = male, 0 = female</td>
</tr>
<tr>
<td>white</td>
<td>1 = white, 0 = nonwhite</td>
</tr>
</tbody>
</table>
Q1: Does decreasing the number of required developmental classes (acceleration) affect the amount students learn?

Technique: Two-sample t-test comparing:
- Phase 3 score on EvCC items for students coming out of the 2-quarter sequence
- Phase 3 score on EvCC items for students coming out of the 3-quarter sequence

\[ H_0: \mu_{2\text{qtr}} = \mu_{3\text{qtr}} \quad H_A: \mu_{2\text{qtr}} \neq \mu_{3\text{qtr}} \]

```
Welch Two Sample t-test
data:  prepost92data$ph3_EvCCaverage and prepost3qtrdata$ph3_EvCCaverage
t = 1.9437, df = 52.785, p-value = 0.05727
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -0.002652935  0.168464900
sample estimates:
mean of x mean of y
0.5760684 0.4931624
```
**Q2:** Is conceptual/contextual math retained longer than procedural algebra?

**Technique:** Two sets of multiple regression

**Predict:** Score on Phase 3 conceptual/contextualized items

**Based on independent variables:**
- Whether a student had taken math the previous quarter (self-reported)
- Age

```
Call: lm(formula = contextscores1XX ~ math_last_qtr1XX + age, data = phase3data)

Residuals:
    Min     1Q Median     3Q    Max
-0.51848 -0.16024  0.01475  0.17584  0.63250

Coefficients:
                     Estimate Std. Error t value Pr(>|t|)
(Intercept)       0.623273   0.036855  16.911  < 2e-16 ***
math_last_qtr1XX  0.018006   0.021701   0.830    0.407
age              -0.005745   0.001423  -4.038 6.48e-05 ***
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.2159 on 400 degrees of freedom
(23 observations deleted due to missingness)
Multiple R-squared:  0.0435, Adjusted R-squared:  0.03871
F-statistic: 9.095 on 2 and 400 DF,  p-value: 0.0001372
```

```
Call: lm(formula = algoscores1XX ~ math_last_qtr1XX + age, data = phase3data)

Residuals:
    Min     1Q Median     3Q    Max
-0.53735 -0.15431 -0.01686  0.12821  0.72390

Coefficients:
                     Estimate Std. Error t value Pr(>|t|)
(Intercept)       0.365459   0.035045  10.428   <2e-16 ***
math_last_qtr1XX  0.223701   0.020635  10.841   <2e-16 ***
age              -0.002886   0.001353  -2.133   0.0335 *
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.2053 on 400 degrees of freedom
(23 observations deleted due to missingness)
Multiple R-squared:  0.2459, Adjusted R-squared:  0.2421
F-statistic: 65.22 on 2 and 400 DF,  p-value: < 2.2e-16
```
Q3: How well do each of the following predict grades in college level classes:

- A student's procedural math skills on the first day of class, or
- Their conceptual/contextual math skills on the first day of class
- Demographic & personal characteristics

**Technique:** Multiple regression

**Predict:** Grades in college-level math

**Based on independent variables:**

- Score on Phase 3 procedural items
- Score on Phase 3 contextual/conceptual items
- Self-reported grade in last 2-3 math courses (ph3_D8r)
- Demographic variables

```
Call: lm(formula = gradesin1XX ~ algoscores1XX + contextscores1XX + ph3_D8r + age + white + SEX + PELL_ELIG, data = phase3day10data)

Residuals:
       Min        1Q      Median        3Q       Max
-3.12350 -0.68580  0.30120  0.90000  3.29980

Coefficients:               Estimate Std. Error   t value  Pr(>|t|)
(Intercept)    0.384319    0.413426   0.9303  0.353290
algoscores1XX  0.186192    0.342635   0.5433  0.587233
contextscores1XX  1.032067    0.337294   3.0601  0.002412 **
ph3_D8r        0.523189    0.098379   5.3177  2.04e-07 ***
age            -0.006728    0.010392  -0.6470  0.517848
white          -0.154775    0.150598  -1.0282  0.304868
SEX             0.076562    0.143142   0.5348  0.593115
PELL_ELIG      0.009604    0.157803   0.0610  0.951509
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 1.25 on 314 degrees of freedom
(63 observations deleted due to missingness)
Multiple R-squared:  0.1488, Adjusted R-squared:  0.1298
F-statistic: 7.843 on 7 and 314 DF,  p-value: 9.217e-09
```

A follow-up regression was done only on students in precalculus, where more algebra might be required.

```
Call: lm(formula = gradesin1XX ~ algoscores1XX + contextscores1XX + ph3_D8r + age + white + SEX + PELL_ELIG, data = phase3classprecalc)

Residuals:
       Min       1Q      Median       3Q       Max
-3.34630 -0.82840  0.19860  0.94870  3.22250

Coefficients:               Estimate Std. Error   t value  Pr(>|t|)
(Intercept)    0.916710    0.580407   1.5790  0.116418
algoscores1XX  0.573710    0.474660   1.2090  0.228760
contextscores1XX  0.885700    0.493853   1.7930  0.074985 .
ph3_D8r        0.518850    0.139631   3.7161  0.000289 ***
age            -0.031610    0.015838  -1.9949  0.047904 *
white          -0.451040    0.210386  -2.1440  0.033705 *
SEX             0.082230    0.203089   0.4050  0.686153
PELL_ELIG      0.156900    0.222680   0.7050  0.482180
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 1.241 on 145 degrees of freedom
(29 observations deleted due to missingness)
Multiple R-squared:  0.2116, Adjusted R-squared:  0.1735
F-statistic: 5.56 on 7 and 145 DF,  p-value: 9.217e-09
```
Q4: How will do the following predict a student’s grade in intermediate algebra:

- How much their math skills improved from day 1 to the start of the next class,
- Their math skills at the start of the next class, or
- Demographic & personal characteristics

**Technique:** Multiple regression

**Predict:** Intermediate algebra grade

**Based on independent variables:**
- Gains on EvCC items (learning in int. alg.)
- Score on Phase 3 EvCC items (skills at start of next quarter)
- Demographic Variables (for control)

```r
Call:
  lm(formula = gradesin9X ~ gains99 + ph3_99score, data = prepost99)
Coefficients:
            Estimate Pr(>|t|)
(Intercept)  1.9605 7.03e-12 ***
gains99       0.3017 0.61643
ph3_99score   1.6413 0.00374 **
---
Residual standard error: 0.6662 on 59 degrees of freedom
Multiple R-squared:  0.3043, Adjusted R-squared:  0.2807
F-statistic:  12.9 on 2 and 59 DF,  p-value: 2.245e-05
```

Follow-up: Three regressions, split up by course

**Predict:** Grade in 92, 98, 99

**Based on independent variables:**
- Gains on a weighted subscale corresponding to the skills taught in each course (learning in int. alg.)
- Scores on Phase 3 items of that subscale (skills at start of next quarter)

```r
Call:
  lm(formula = gradesin9X ~ evccgains + ph3_EvCCaverage + SEX + PELL_ELIG + white, data = prepostdata)
Residuals:
   Min     1Q  Median     3Q    Max
-2.09684 -0.58167  0.01417  0.62912  1.45540
Coefficients:
            Estimate Std. Error t value Pr(>|t|)
(Intercept)      2.52001    0.28658   8.793 4.34e-14 ***
evccgains        0.70895    0.60380   1.174   0.2431
ph3_EvCCaverage  0.96293    0.56889   1.693   0.0936 .
SEX              -0.07616    0.15796  -0.482   0.6307
PELL_ELIG         0.04592    0.16494   0.278   0.7813
white            -0.28127    0.17393  -1.617   0.1090
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1
Residual standard error: 0.7927 on 100 degrees of freedom
(168 observations deleted due to missingness)
Multiple R-squared:  0.1268, Adjusted R-squared:  0.08312
F-statistic: 2.904 on 5 and 100 DF,  p-value: 0.01723
```

```r
Call:
  lm(formula = gradesin9X ~ gains92 + ph3_92score, data = prepost92)
Coefficients:
            Estimate Pr(>|t|)
(Intercept)  2.61257 4.64e-08 ***
gains92      0.85367    0.458
ph3_92score  0.05195    0.967
---
Residual standard error: 0.9073 on 42 degrees of freedom
Multiple R-squared:  0.04318, Adjusted R-squared: -0.00238
F-statistic: 0.9478 on 2 and 42 DF,  p-value: 0.3957
```

```r
Call:
  lm(formula = gradesin9X ~ gains98 + ph3_98score, data = prepost98)
Coefficients:
            Estimate Pr(>|t|)
(Intercept)   3.0802 0.000415 ***
gains98       4.4089 0.000992 ***
ph3_98score  -2.0058 0.168664
---
Residual standard error: 0.3899 on 9 degrees of freedom
Multiple R-squared:  0.7758, Adjusted R-squared:  0.726
F-statistic: 15.57 on 2 and 9 DF,  p-value: 0.001196
```
Math Skills Assessment

Please carefully answer each of the following questions to the best of your ability. The following data will be used in aggregate to analyze the test results and will not be stored on your record or shared with outside entities. This information will only be used for research purposes.

1. Name: ________________________________________________

2. Student ID number (should start with 804): ___ ___ ___ - ___ ___ - ___ ___ ___ ___

3. Current Math Class: ____________________ (107, 138, 141, 146)

4. What was the last math class you took before this one? (Circle one)
   Math 92 at EvCC   Math 98 at EvCC   Math 99 at EvCC

   Other (List, including where): ____________________________________________

Based on the last math class you took rate how much you agree with the following statements.

a) I entered this class with the math skills needed to succeed in the class.

   1       2          3              4                  5
   Strongly Disagree                  Neutral             Strongly Agree

b) The class went too fast for me.

   1       2          3              4                  5
   Strongly Disagree                  Neutral             Strongly Agree

c) The class went too slow for me.

   1       2          3              4                  5
   Strongly Disagree                  Neutral             Strongly Agree

d) The textbook in the class was important for my learning

   1       2          3              4                  5
   Strongly Disagree                  Neutral             Strongly Agree

e) The homework assignments in the class helped me learn.

   1       2          3              4                  5
   Strongly Disagree                  Neutral             Strongly Agree

f) The class positively influenced my attitude toward math.

   1       2          3              4                  5
   Strongly Disagree                  Neutral             Strongly Agree

g) I would recommend this class to others.

   1       2          3              4                  5
   Strongly Disagree                  Neutral             Strongly Agree

h) How long has it been since you took your last math class:

   Last quarter/term  4 months – 1 year  1-2 years  More than 2 years
Math Skills Assessment

5. How much do you agree with the statement: “I am pretty good at math.”

<table>
<thead>
<tr>
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<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Strongly Disagree</td>
<td>Neutral</td>
<td>Strongly Agree</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

6. How much do you agree with the statement: “I enjoy learning math.”

<table>
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<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Strongly Disagree</td>
<td>Neutral</td>
<td>Strongly Agree</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

7. With regards to the last two math classes you’ve taken, how much do you agree with the following statement: “The amount of work I put in has had a large effect on my performance in the class.”

<table>
<thead>
<tr>
<th></th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Strongly Disagree</td>
<td>Neutral</td>
<td>Strongly Agree</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

8. What have your math grades averaged over the last two or three math courses you’ve taken? (Give your best estimate.)

| A | B | C | D | F |

9a) Have you decided on a major? Yes No

9b) What is your most likely major? ____________________________

9c) How confident are you that this will be your final major?

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<tr>
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<th>1</th>
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<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Not confident</td>
<td>Very Confident</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

10. The math learning process often requires mastering one skill and then progressing onto the next step and the next. Some students move from one step to the next relatively easily while others find it more challenging. Thinking about all your recent math courses, how would you rate yourself on this?

a. I almost always have problems with this.
b. I often have problems with this.
c. I'm kind of in the middle on this.
d. I don’t often have problems with this.
e. I almost never have problems with this.

11. Are you the first person in your immediate family to go to college? Yes No
Math Skills Assessment

Do all your work in the test booklet. Please write your answer on the line provided.

1. Simplify the expression. Make sure that all like terms are combined.
   \[(3x^2 + 10x - 4) - (x^2 + x - 6)\]

2. Solve for y.
   \[0 = y^2 + 2y - 4\]

3. Simplify the given expression. This includes making sure there are no parentheses, reducing all fractions, and writing any numbers as simply as possible.
   \[(8x^3y^9)^{1/3}\]

4. Factor completely.
   \[x^2 - 11x + 30\]
Math Skills Assessment

5. Polonium-218 decays exponentially. It has a half-life of 8 days. In other words, every 8 days half of the polonium that you had at the beginning of that 8 days has decayed and is gone. You have a sample of 48 grams of Polonium-218 at \( t = 0 \), where \( t \) is given in days.

(a) Complete the table of values which gives the amount of polonium-218 you have remaining.

<table>
<thead>
<tr>
<th>( t )</th>
<th>( P )</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td></td>
</tr>
<tr>
<td>32</td>
<td></td>
</tr>
<tr>
<td>40</td>
<td></td>
</tr>
</tbody>
</table>

(b) The data fits an exponential equation of the form \( P = A \left( \frac{1}{2} \right)^{\frac{t}{B}} \) where \( P \) is the amount of Polonium-218 you have on day \( t \). What should \( A \) and \( B \) be in the equation in order for the equation to fit the data?

\[ A = \ldots \quad B = \ldots \]

(c) Sketch a graph which gives the amount of polonium-218 after \( t \) days. Make your \( t \) axis go from \( t = 0 \) to \( t = 40 \).
Math Skills Assessment

6. Find the value of the expression. Write your answer as an integer or reduced fraction.

\[ \log_2(64) \]

7. Solve for \( x \).

\[ \sqrt[3]{2x + 3} - 5 = -2 \]

8. Find all values of \( y \) that satisfy the inequality.

\[ |2y - 9| < 5 \]
Math Skills Assessment

9. Write as a single logarithm. Make sure there is nothing outside the argument of the log and that all fractions are reduced.

\[ 3 \log(y) - \log(x) \]

10. Simplify the expression. Make sure all like factors are combined and that everything possible is pulled out of the radical.

\[ \left( \sqrt[3]{18x^7} \right) \left( \sqrt[3]{12x^2} \right) \]

11. Simplify the given expression. Make sure that everything is combined in one fraction and that all like terms are combined.

\[ \frac{2x + 7}{x + 3} - \frac{x + 14}{2(x + 3)} \]
Math Skills Assessment

Please rewrite your name and Student ID number below.
(The number should start with 804.)

Name:_______________________________

Student ID Number: ___ ___ ___ - ___ ___ - ___ ___ ___ ___
Math Skills Assessment

House Prices
This problem gives you the chance to:
• work with graphs and formulas in a real context

In March 2006, a newspaper article reported that houses in Maryland are so expensive that many people are unable to afford the monthly house payments.

This graph shows the average house price and the average monthly payment for all the different counties in Maryland.

![House Prices and Payments Graph]

1. 
   a. What does the pattern of the data indicate about the connection between house prices and monthly payments?

   b. Find the monthly payment for a house costing $450 000.

   c. Find a formula connecting the average monthly payment with the average house price.
Math Skills Assessment

This graph shows the average monthly wage and the average monthly house payment for each county in Maryland.

2.
   a. Describe the pattern of the data.

   ______________________________________________________________

   b. Draw a ring round the point representing the county where the average person will find it most difficult to afford the monthly house payment. Label this point with the letter A.

   ______________________________________________________________

   c. Draw a ring round the point representing the county where the average person will find it easiest to afford the monthly house payment. Label this point with the letter B.

   ______________________________________________________________

   d. Indicate clearly which part of the graph contains points representing counties where the average monthly house payment is more than the average monthly wage.

   ______________________________________________________________
Buying Chips and Candy

This problem gives you the chance to:
• form and solve a pair of linear equations in a practical situation

Ralph and Jody go to the shop to buy potato chips and candy bars.

Ralph buys 3 bags of potato chips and 4 candy bars. He spends $3.75.

Jody buys 4 bags of potato chips and 2 candy bars. She spends $3.00.

Later Clancy joins Ralph and Jody and asks to buy one bag of potato chips and one candy bar from them. They need to work out how much he should pay.

Ralph writes

\[ 3p + 4b = 375 \]

1. If \( p \) stands for the cost, in cents, of a bag of potato chips and \( b \) stands for the cost, in cents, of a candy bar, what does the 375 in Ralph’s equation mean?

2. Write a similar equation, using \( p \) and \( b \), for the items Jody bought.
3. Use the two equations to figure out the price of a bag of potato chips and the price of a candy bar.

\[ \text{potato chips} \]
\[ \text{candy bar} \]

Show your work.

4. Clancy has just $1. Does he have enough money to buy a bag of potato chips and a candy bar?

Explain your answer by showing your calculation.
Math Skills Assessment

Sorting Functions
This problem gives you the chance to:
• Find relationships between graphs, equations, tables and rules
• Explain your reasons

On the next page are four graphs, four equations, four tables, and four rules. Your task is to match each graph with an equation, a table and a rule.

1. Write your answers in the following table.

<table>
<thead>
<tr>
<th>Graph</th>
<th>Equation</th>
<th>Table</th>
<th>Rule</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>B</td>
<td></td>
<td></td>
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<tr>
<td>C</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>D</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2. Explain how you matched each of the four graphs to its equation.
   
   **Graph A**
   
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________

   **Graph B**
   
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________

   **Graph C**
   
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________

   **Graph D**
   
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
   ____________________________________________________________
Math Skills Assessment

Each graph will match one equation, one table, and one rule. Matching parts won’t necessarily be next to each other.

<table>
<thead>
<tr>
<th>Graphs</th>
<th>Equations</th>
<th>Tables</th>
<th>Rules</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Graph A</strong></td>
<td>$xy = 2$</td>
<td><strong>Table A</strong></td>
<td><strong>Rule A</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><em>y</em> is the same as <em>x</em> multiplied by <em>x</em></td>
</tr>
<tr>
<td><strong>Graph B</strong></td>
<td>$y^2 = x$</td>
<td><strong>Table B</strong></td>
<td><strong>Rule B</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><em>x</em> multiplied by <em>y</em> is equal to 2</td>
</tr>
<tr>
<td><strong>Graph C</strong></td>
<td>$y = x^2$</td>
<td><strong>Table C</strong></td>
<td><strong>Rule C</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><em>y</em> is 2 less than <em>x</em></td>
</tr>
<tr>
<td><strong>Graph D</strong></td>
<td>$y = x - 2$</td>
<td><strong>Table D</strong></td>
<td><strong>Rule D</strong></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td><em>x</em> is the same as <em>y</em> multiplied by <em>y</em></td>
</tr>
</tbody>
</table>