**Activity 8.3.4 Am I your Inverse?**

For real numbers, the multiplicative inverse of a number gives 1 (the identity) when multiplying the original number. Example, the multiplicative inverse of $\frac{2}{3} is \frac{3}{2} because \left(\frac{2}{3}\right)\left(\frac{3}{2}\right)=1 $

1. With real numbers, we call the multiplicative inverse the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

Also if $\frac{2}{3} is the multiplicative inverse of \frac{3}{2}, \frac{3}{2} is the multiplicative inverse of \frac{2}{3}.$

**We saw in investigation 1 that some matrices have inverses.**

As with real numbers, for two matrices, if $B is the multiplicative inverse of A, then AB=I, and BA=I.$

1. What does that mean in terms of the shape and size of *A* and *B*?
2. Now let’s practice multiplying matrices to see if two matrices are inverses. Let:

$$A=\left[\begin{matrix}2&4&6\\3&4&5\\1&0&3\end{matrix}\right]$$

$$B=\left[\begin{matrix}1&0&0\\0&1&0\\0&0&1\end{matrix}\right]$$

$$C=\left[\begin{matrix}1&1&1\\1&1&1\\1&1&1\end{matrix}\right]$$

$$D=\left[\begin{matrix}-\frac{3}{4}&\frac{3}{4}&\frac{1}{4}\\\frac{1}{4}&0&-\frac{1}{2}\\\frac{1}{4}&-\frac{1}{4}&\frac{1}{4}\end{matrix}\right]$$

Use technology to find the following product matrices:

$$AB=$$

$$AC=$$

$$AD=$$

1. So which matrix is $A^{-1}? $
2. Use technology to find the inverses of matrices, B, C and D.

$$B^{-1}=$$

$$C^{-1}=$$

$$D^{-1}=$$

1. Did all the matrices have a multiplicative inverse?
2. We can use some algebra to see if $A=\left[\begin{matrix}2&4\\3&6\end{matrix}\right]$ has an inverse matrix.

$$\left[\begin{matrix}2&4\\3&6\end{matrix}\right]\left[\begin{matrix}a&b\\c&d\end{matrix}\right]=\left[\begin{matrix}1&0\\0&1\end{matrix}\right]$$

$$2a+4c=1$$

$$2b+4d=0, so b=-2d$$

$$3a+6c=0, so a=-2c$$

$$3b+6d=1$$

1. Where did the 4 equations come from?
2. Solve the system. Does A have an inverse?

If a matrix *A* has an inverse, we call the inverse $A^{-1}$, and $A\*A^{-1}=A^{-1}\*A=I$. A matrix can only have an inverse if it is a square matrix. Not all square matrices have inverses. A matrix that has an inverse is called a ***nonsingular matrix.*** A matrix that does not have an inverse is called a ***singular matrix.*** We will find the inverse of a matrix (if it has one) first using the graphing calculator and then in later investigations by hand.