FOUR IN A ROW: Multiplying Rational Numbers

Associative Property of Multiplication

The **associative property of multiplication** says that $(a \times b) \times c = a \times (b \times c)$. This property allows us to multiply a sequence of more than two numbers. Because only two numbers at can be multiplied at one time, we use the associative property to associate the two numbers we want to multiply at each step. No matter which two numbers we associate to multiply, the product will be the same; for example, $(1/3 \times {}^{-}4/3) \times 4 = 1/3 \times ({}^{-}4/3 \times 4)$.

Game Description and Materials

Four in a Row is a game for two players that uses the associative property of multiplication to give students mental math practice multiplying positive and negative fractions. Players complete rows on a Game Board to demonstrate the two ways the associative property can be used to simplify three-factor expressions.

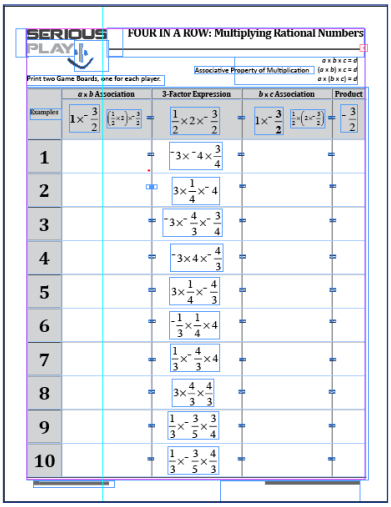
Game materials include a Game Board (print one for each player) and a set of cards.

The **object of the game** is to complete more rows than the other player.

Game Board

The Game Board consists of four columns with examples at the top.

1. The cards that belong in the ***axb* association** column use bold type to show that the first two factors are associated and multiplied.
2. The **3-factor expression** column shows multiplication expressions containing three factors.
3. The cards that belong in the ***bxc* association** column use bold type to show that the second two factors are associated and multiplied.
4. The **product** column shows the product of the factors (the simplified expression).



Cards

- **Expression Cards:** There are 20 Expression Cards, two for each 3-factor expression. Ten cards show the *axb* association; ten cards show *bxc* association. This example shows the two Game Game Cards for $-1/3 \times 1/4 \times 4$: $-\frac{1}{12}\times 4$ $-\frac{1}{3}\times 1$
- **Product Cards:** There are ten Product Cards. Product Cards are used to protect a row belonging to a player. This example shows the Sum Card for $7 \times 2 \times 4$: $-\frac{1}{3}$
- **Chance Cards:** There are six Chance Cards. Players use Chance Cards 1) to protect rows in which they have already placed one Expression Card OR 2) to take an Expression Card from the opponent's Game Board. CHANCE

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Getting Ready to Play

Each player takes a Game Board. The dealer shuffles the Expression Cards and the Chance Cards together and places them face down in a stack to form a draw pile. Sum Cards are spread out, face up, so the sums are easy to see.

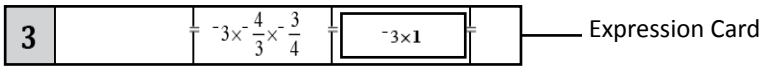
Let's Play!

1. Players decide who takes the first turn. They alternate turns, drawing the top card from the draw pile.

2. As they play, they place cards on the Game Board according to the following directions:

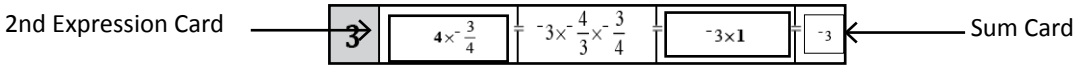
- **Expression Cards**

  When a player draws an **Expression Card,** he places it in the correct space (row and column) on his Game Board.



- **Product Cards**

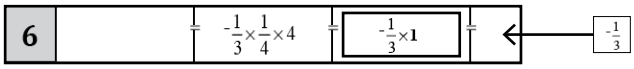
  When a player places a second Expression Card on his Game Board and fills both the *a+b and b+c* spaces, he picks the correct **Product Card** and places it in the Product Space in that row. The Product Card protects the row and reserves it for that player.



- **Chance Cards**

  When a player draws a Chance Card, he may use it, *on that turn*, in one of two ways (Chance Cards are discarded after they are used):

  1. If he has an Expression Card in either column, he may protect/reserve that row by taking the correct Product Card and placing it at the end of that row. His opponent, then, cannot take his Expression Card and place it on her own Game Board.



  2. If he has one Expression Card on a row but is missing the other Expression Card, he may take the missing card from the opponent's board (*only* if that row is unprotected) and place it on his own board. Then, he takes a Product Card to protect that row.

3. The game is over when all the draw pile is gone.

4. The winner is the player with more completed rows.

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Associative Property of Multiplication

$a \times b \times c = d$
$(a \times b) \times c = d$
$a \times (b \times c) = d$

	***a* x *b* Association**	**3-Factor Expression**	***b* x *c* Association**	**Product**
Examples	$\mathbf{1} \times {}^{-}\frac{3}{2} \quad \left(\frac{1}{2} \times 2\right) \times {}^{-}\frac{3}{2}$	$= \frac{1}{2} \times 2 \times {}^{-}\frac{3}{2} =$	$1 \times {}^{-}\frac{\mathbf{3}}{\mathbf{2}} \quad \frac{1}{2} \times \left(2 \times {}^{-}\frac{3}{2}\right)$	$= -\frac{3}{2}$
1		$= {}^{-}3 \times {}^{-}4 \times \frac{3}{4} =$		
2		$= 3 \times \frac{1}{4} \times {}^{-}4 =$		
3		$= {}^{-}3 \times {}^{-}\frac{4}{3} \times {}^{-}\frac{3}{4} =$		
4		$= {}^{-}3 \times 4 \times {}^{-}\frac{4}{3} =$		
5		$= 3 \times \frac{1}{4} \times {}^{-}\frac{4}{3} =$		
6		$= {}^{-}\frac{1}{3} \times \frac{1}{4} \times 4 =$		
7		$= \frac{1}{3} \times {}^{-}\frac{4}{3} \times 4 =$		
8		$= 3 \times \frac{4}{3} \times \frac{4}{3} =$		
9		$= \frac{1}{3} \times {}^{-}\frac{3}{5} \times \frac{3}{4} =$		
10		$= \frac{1}{3} \times {}^{-}\frac{3}{5} \times \frac{4}{3} =$		

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Examples	$\mathbf{1} \times {}^{-}\frac{3}{2} \quad \left(\frac{1}{2} \times 2\right) \times {}^{-}\frac{3}{2}$	$= \frac{1}{2} \times 2 \times {}^{-}\frac{3}{2} =$	$1 \times {}^{-}\frac{\mathbf{3}}{\mathbf{2}} \quad \frac{1}{2} \times \left(2 \times {}^{-}\frac{3}{2}\right)$	$= -\frac{3}{2}$
1		$= {}^{-}3 \times {}^{-}4 \times \frac{3}{4} =$		
2		$= 3 \times \frac{1}{4} \times {}^{-}4 =$		
3		$= {}^{-}3 \times {}^{-}\frac{4}{3} \times {}^{-}\frac{3}{4} =$		
4		$= {}^{-}3 \times 4 \times {}^{-}\frac{4}{3} =$		
5		$= 3 \times \frac{1}{4} \times {}^{-}\frac{4}{3} =$		
6		$= {}^{-}\frac{1}{3} \times \frac{1}{4} \times 4 =$		
7		$= \frac{1}{3} \times {}^{-}\frac{4}{3} \times 4 =$		
8		$= 3 \times \frac{4}{3} \times \frac{4}{3} =$		
9		$= \frac{1}{3} \times {}^{-}\frac{3}{5} \times \frac{3}{4} =$		
10		$= \frac{1}{3} \times {}^{-}\frac{3}{5} \times \frac{4}{3} =$		

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Cards

$\mathbf{12} \times \frac{3}{4}$	$-\frac{\mathbf{1}}{\mathbf{12}} \times 4$	$^{-}3 \times {}^{-}\mathbf{3}$	$-\frac{1}{3} \times \mathbf{1}$
$\frac{\mathbf{3}}{\mathbf{4}} \times {}^{-}4$	$-\frac{\mathbf{4}}{\mathbf{9}} \times 4$	$3 \times {}^{-}\mathbf{1}$	$\frac{1}{3} \times {}^{-}\frac{\mathbf{16}}{\mathbf{3}}$
$^{-}\mathbf{4} \times {}^{-}\frac{3}{4}$	$\mathbf{4} \times \frac{4}{3}$	$^{-}3 \times \mathbf{1}$	$^{-}3 \times \frac{\mathbf{16}}{\mathbf{9}}$
$\mathbf{12} \times {}^{-}\frac{3}{4}$	$-\frac{\mathbf{1}}{\mathbf{5}} \times \frac{3}{4}$	$3 \times {}^{-}\frac{\mathbf{16}}{\mathbf{3}}$	$\frac{1}{3} \times {}^{-}\frac{\mathbf{9}}{\mathbf{20}}$
$\frac{\mathbf{3}}{\mathbf{4}} \times {}^{-}\frac{4}{3}$	$-\frac{\mathbf{1}}{\mathbf{5}} \times \frac{4}{3}$	$3 \times {}^{-}\frac{\mathbf{1}}{\mathbf{3}}$	$\frac{1}{3} \times {}^{-}\frac{\mathbf{4}}{\mathbf{5}}$
CHANCE Take a Product Card to protect a row **OR** Take opponent's card from unprotected row.	**CHANCE** Take a Product Card to protect a row **OR** Take opponent's card from unprotected row.	**CHANCE** Take a Product Card to protect a row **OR** Take opponent's card from unprotected row.	**CHANCE** Take a Product Card to protect a row **OR** Take opponent's card from unprotected row.
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9	$^{-}3$	$^{-}3$	16	$^{-}1$	$-\frac{1}{3}$	$-\frac{16}{9}$	$\frac{16}{3}$	$-\frac{3}{20}$	$-\frac{4}{15}$

SERIOUS PLAY

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Answer Key

Associative Property of Multiplication

$a \times b \times c = d$

$(a \times b) \times c = d$

$a \times (b \times c) = d$

Print two Game Boards, one for each player.

	***a* x *b* Association**	**3-Factor Expression**	***b* x *c* Association**	**Product**
Examples	$\mathbf{1}\times^{-}\frac{3}{2}$ $\left(\frac{1}{2}\times 2\right)\times^{-}\frac{3}{2}$	$=\frac{1}{2}\times 2\times^{-}\frac{3}{2}$	$=1\times^{-}\mathbf{\frac{3}{2}}$ $\frac{1}{2}\times\left(2\times^{-}\frac{3}{2}\right)$	$=-\frac{3}{2}$
1	$\mathbf{12}\times\frac{3}{4}$	$=^{-}3\times^{-}4\times\frac{3}{4}$	$=^{-}3\times^{-}\mathbf{3}$	$=9$
2	$\mathbf{\frac{3}{4}}\times^{-}4$	$=3\times\frac{1}{4}\times^{-}4$	$=3\times^{-}\mathbf{1}$	$=^{-}3$
3	$\mathbf{4}\times^{-}\frac{3}{4}$	$=^{-}3\times^{-}\frac{4}{3}\times^{-}\frac{3}{4}$	$=^{-}3\times\mathbf{1}$	$=^{-}3$
4	$^{-}\mathbf{12}\times^{-}\frac{4}{3}$	$=^{-}3\times 4\times^{-}\frac{4}{3}$	$=^{-}3\times^{-}\mathbf{\frac{16}{3}}$	$=16$
5	$\mathbf{\frac{3}{4}}\times^{-}\frac{4}{3}$	$=3\times\frac{1}{4}\times^{-}\frac{4}{3}$	$=3\times^{-}\mathbf{\frac{1}{3}}$	$=^{-}1$
6	$-\mathbf{\frac{1}{12}}\times 4$	$=-\frac{1}{3}\times\frac{1}{4}\times 4$	$=-\frac{1}{3}\times\mathbf{1}$	$=-\frac{1}{3}$
7	$-\mathbf{\frac{4}{9}}\times 4$	$=\frac{1}{3}\times^{-}\frac{4}{3}\times 4$	$=\frac{1}{3}\times^{-}\mathbf{\frac{16}{3}}$	$=-\frac{16}{9}$
8	$\mathbf{4}\times\frac{4}{3}$	$=3\times\frac{4}{3}\times\frac{4}{3}$	$=3\times\mathbf{\frac{16}{9}}$	$=\frac{16}{3}$
9	$-\mathbf{\frac{1}{5}}\times\frac{3}{4}$	$=\frac{1}{3}\times^{-}\frac{3}{5}\times\frac{3}{4}$	$=\frac{1}{3}\times^{-}\mathbf{\frac{9}{20}}$	$=-\frac{3}{20}$
10	$-\mathbf{\frac{1}{5}}\times\frac{4}{3}$	$=\frac{1}{3}\times^{-}\frac{3}{5}\times\frac{4}{3}$	$=\frac{1}{3}\times^{-}\mathbf{\frac{4}{5}}$	$=-\frac{4}{15}$