The Algebra of Matrices

$$A(BC) = (AB)C \text{ Multiplication is Associative}$$
$$A(B+C) = AB + AC \text{ Multiplication (on left) Distributes Over Addition}$$
$$(B+C)A = BA + CA \text{ Multiplication (on right) Distributes Over Addition}$$

For real numbers these two distributive properties are the same. For matrices they are different because:

$$AB \neq BA \;\text{ (in general) Multiplication is not Commutative}$$

Example:

$$E = E_{12}(-2) = \begin{bmatrix} 1 & 0 & 0 \\ -2 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix}, F = E_{13}(1) = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 1 & 0 & 1 \end{bmatrix} \Rightarrow EF = FE$$

Indeed, both EF and FE perform the first two steps in G-E on A, i.e. arranging zeros below the first pivot. The order we do this in shouldn't matter.