Suppose that matrix A is $m \times n$ and matrix B is $n \times p$. Then the matrix multiplication is possible. Thinking in blocks,

$$AB = A[\mathbf{b}_1 \ \mathbf{b}_2 \ \dots \ \mathbf{b}_P] = [A\mathbf{b}_1 \ A\mathbf{b}_2 \ \dots \ A\mathbf{b}_p].$$

However, each $A\mathbf{b}_j$ is a linear combination of the columns of matrix A.

$$\begin{aligned} A\mathbf{b}_j &= [\mathbf{a}_1 \ \mathbf{a}_2 \ \dots \ \mathbf{a}_n] \begin{pmatrix} b_{1j} \\ b_{2j} \\ \vdots \\ b_{nj} \end{pmatrix} \\ &= b_{1j}\mathbf{a}_1 + b_{2j}\mathbf{a}_2 + \cdots + b_{nj}\mathbf{a}_n \end{aligned}$$

Therefore, each column of matrix AB is a linear combination of the columns of A. This means that everything in the column space of AB also belongs to the column space of A.

For example, if

$$A = \begin{pmatrix} 1 & 4 & 7 \\ 2 & 5 & 8 \\ 3 & 6 & 9 \end{pmatrix} \qquad \text{and} \qquad \begin{pmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{pmatrix},$$

then

$$\begin{aligned} AB &= \begin{pmatrix} 1 & 4 & 7 \\ 2 & 5 & 8 \\ 3 & 6 & 9 \end{pmatrix} \begin{pmatrix} 1 & 1 & 0 \\ 0 & 1 & 0 \\ 1 & 0 & 0 \end{pmatrix} \\ &= \left(\begin{pmatrix} 1 & 4 & 7 \\ 2 & 5 & 8 \\ 3 & 6 & 9 \end{pmatrix} \begin{pmatrix} 2 \\ 0 \\ 0 \end{pmatrix}, \quad \begin{pmatrix} 1 & 4 & 7 \\ 2 & 5 & 8 \\ 3 & 6 & 9 \end{pmatrix} \begin{pmatrix} 2 \\ 0 \\ 0 \end{pmatrix}, \quad \begin{pmatrix} 1 & 4 & 7 \\ 2 & 5 & 8 \\ 3 & 6 & 9 \end{pmatrix} \begin{pmatrix} 2 \\ 0 \\ 0 \end{pmatrix}, \right) \\ &= \left(2 \begin{pmatrix} 1 \\ 2 \\ 3 \end{pmatrix}, \quad 2 \begin{pmatrix} 1 \\ 2 \\ 3 \end{pmatrix} + 3 \begin{pmatrix} 4 \\ 5 \\ 6 \end{pmatrix}, \quad \begin{pmatrix} 0 \\ 0 \\ 0 \end{pmatrix} \right) \end{aligned}$$

Note that each column of AB is a linear combination of the columns of A. Thus, any combination of the columns of AB will actually be a combination of the columns of A. Indeed, only the first two columns of matrix A are used, so the column space of AB is properly contained in the column space of matrix A.