5.8.27

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The students of a class are made to stand in rows. If 3 students are extra in a row, there would be 1 row less. If 3 students are less in a row, there would be 2 rows more. Find the number of students in the class using matrices.

Theoretical Solution

To find the total number of students, we first define our variables and set up a system of linear equations. Let x be the number of rows and y be the number of students per row. The total number of students is xy.

From the problem statement, we derive two equations:

$$(x - 1)(y + 3) = xy \implies 3x - y = 3$$
$$(x + 2)(y - 3) = xy \implies -3x + 2y = 6$$

We can solve this system using an augmented matrix and Gaussian elimination. We begin by creating an augmented matrix $\left(A \mid B\right)$ for this system.

The augmented matrix for this system is:

$$\left(A \mid B\right) = \begin{pmatrix} 3 & -1 & \bigm| & 3 \\ -3 & 2 & \bigm| & 6 \end{pmatrix} \tag{1}$$

Theoretical Solution

The goal is to use elementary row operations to transform the left side of the augmented matrix into row-echelon form. We perform the operation $R_2 \to R_2 + R_1$:

$$\left(\begin{array}{cc|c} 3 & -1 & 3 \\ -3+3 & 2+(-1) & 6+3 \end{array}\right) \tag{2}$$

After performing the operation, the matrix becomes:

$$\left(\begin{array}{cc|c} 3 & -1 & 3 \\ 0 & 1 & 9 \end{array}\right) \tag{3}$$

From this row-echelon form, we can use back-substitution. The second row gives us the equation $0x + 1y = 9$, which means $y = 9$. Substituting $y = 9$ into the first row's equation, $3x - y = 3$:

$$3x - 9 = 3$$
$$3x = 12$$
$$x = 4$$

Theoretical Solution

We have found there are $x = 4$ rows and $y = 9$ students per row.
The total number of students is $x \times y = 4 \times 9 = 36$.

C Code

```c
#include <stdio.h>

void print_matrix(float matrix[2][3]) {
    for (int i = 0; i < 2; i++) {
        for (int j = 0; j < 3; j++) {
            printf("%8.2f ", matrix[i][j]);
        }
        printf("\n");
    }
}

int main() {
    float matrix[2][3] = {
        {3.0, -1.0, 3.0},
        {-3.0, 2.0, 6.0}
    };

    printf("Initial Augmented Matrix:\n");
    print_matrix(matrix);
```

```c
    for (int j = 0; j < 3; j++) {
        matrix[1][j] = matrix[1][j] + matrix[0][j];
    }
    printf("\nMatrix after Row Operation (R2 -> R2 + R1):\n");
    print_matrix(matrix);
    float y = matrix[1][2] / matrix[1][1];
    float x = (matrix[0][2] - (matrix[0][1] * y)) / matrix[0][0];
    int total_students = (int)(x * y);

    printf("\n--- Solution ---\n");
    printf("Number of rows (x): %.0f\n", x);
    printf("Number of students per row (y): %.0f\n", y);
    printf("Total number of students in the class: %d\n",
        total_students);

    return 0;
}
    return 1;
```