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PRACTICAL APPLICATIONS OF SYSTEMS OF EQUATIONS

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Keywords: mathematical concepts, graphical method, addition method, subtraction method, substitution method, determinant method.

Abstract: This article examines the application of various mathematical operations in solving systems of equations. Several solution methods, including the graphical method, addition and subtraction methods, substitution method, and determinant method, are demonstrated. The use of multiple approaches facilitates the integration of different mathematical concepts and provides students with a more comprehensive understanding of the topic, thereby enhancing the effectiveness of the learning process.

Introduction

At present, both secondary and higher education institutions employ various methods for solving mathematical problems. Drawing upon these approaches, this article aims to provide a generalized overview of the principal techniques used in solving systems of equations. It is hoped that the presented material will facilitate students' understanding and enhance their analytical thinking skills.

A wide range of problem collections with diverse levels of complexity and content are available to support the consolidation of students' knowledge. Prospective educators should be capable of solving a given type of problem using multiple methods and explaining these approaches in a clear and accessible manner. Since every student possesses a unique perspective, imagination, and level of prior knowledge, demonstrating several solution methods allows learners to choose the approach that best aligns with their individual learning styles and understanding.

Problem-solving activities play a crucial role in developing students' imagination, broadening their worldview, and enhancing their ability to analyze real-life phenomena. Furthermore, they help learners acquire techniques for estimating and predicting quantities and processes that occur in everyday life. The study of mathematics also contributes significantly to the development of mathematical modeling skills. Such skills not only promote future advancements in scientific and technological fields but also enable individuals to better understand, interpret, and conceptualize changes occurring in their surrounding environment.

Literature Review and Methodology

The use of interdisciplinary connections through problem-solving plays an important role in the educational process. Problem-solving techniques are not limited to mathematics; they can also be effectively applied in other disciplines, such as chemistry, biology, physics, and various fields of science. These methods help students develop analytical thinking and enable them to transfer mathematical reasoning to practical and scientific contexts.

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Problem 1

As a result of archaeological excavations, a collection of ancient gold and silver coins was discovered. The total number of coins was 11, and their combined mass was 98 grams. It is known that each gold coin has a mass of 10 grams, while each silver coin weighs 2 grams less than a gold coin. Determine the number of gold and silver coins.

Discussion and Results

Method I: Substitution Method

Let:

- X= number of gold coins,
- Y= number of silver coins.

Since each gold coin weighs 10 g and each silver coin weighs 10−2=8 g, the total masses of the gold and silver coins can be represented as 10x and 8y, respectively.

From the problem statement, we obtain the following system of equations:

$$\begin{cases} x+y=11 \\ 10x+8y=98 \end{cases}$$

From the first equation,

$$x=11-y$$

Substituting this expression into the second equation gives:

$$10(11-y)+8y=98$$

Expanding and simplifying:

$$110-10y+8y=98$$

$$110-2y=98$$

Moving the constant terms to one side:

$$110-98=2y$$

$$12=2y$$

Substituting y=6:

$$x=11-6=5$$

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Therefore,

x=5, y=6

Answer

The collection consists of **5 gold coins** and **6 silver coins**.

Method II

Form a system of linear equations with two unknowns and solve it using the algebraic addition method. We use the same approach as applied in the first method.

1. The unknowns are defined, and the first algebraic equation is formed.

x+y= 11 is multiplied by (−8)-8x-8y=-88
10x+8y=98
-8x-8y=-88
10x+8y=98
2x+0=10
x=5
x+y= 11 .
5+y=11 y=11-5 y=6
Answer: There are 5 gold coins and 6 silver coins.

Method III

Solving a system of equations with two unknowns using the graphical method.

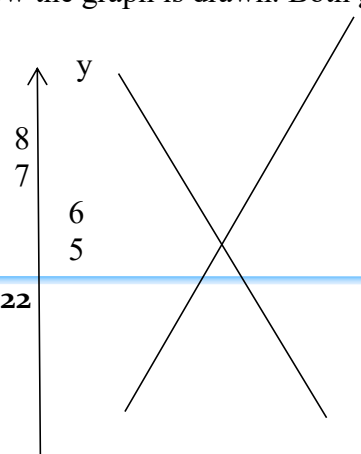
x+y=11
10x+8y=98

x=11-y
y=11-x
10x =98-8y
8y=98-10x
$y=\frac{98-10x}{8}$

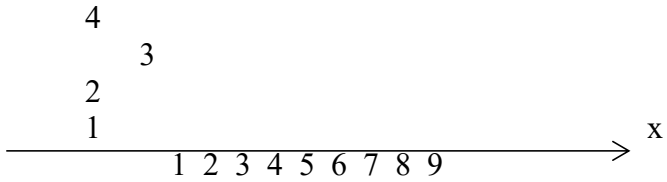
x	1	2	4	5	6	7
y	10	9	7	6	5	4

x	1	2	3	5
y	11	9,75	8.5	6

Now the graph is drawn. Both graphs are placed on the same coordinate plane.



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In this case, the values of xxx and yyy are determined at the point where the graphs intersect.

O(5;6) x=5 y=6

Answer: There are 5 gold coins and 6 silver coins.

Method IV

Solving a system of equations with two unknowns using the determinant method. We use the system of equations presented in the previous methods.

x+y=11 $D=\begin{vmatrix} a & b \\ a & b \end{vmatrix}$ =a b- a b

10x+8y =98 D≠0

$D=\begin{vmatrix} 1 & 1 \\ 10 & 8 \end{vmatrix}$=10-8=2

$D_x=\begin{vmatrix} c1 & b1 \\ c2 & b2 \end{vmatrix}$ $=c_1b_2-c_2b_1$ $x=-\frac{Dx}{D}$

$D_x=\begin{vmatrix} 11 & 1 \\ 98 & 8 \end{vmatrix}$=88-98=10 x=5

$D_y=\begin{vmatrix} a1 & c1 \\ a2 & c2 \end{vmatrix}$ $=a_1c_2-a_2c_1=$ $y=-\frac{Dy}{D}$

$D_y=\begin{vmatrix} 1 & 11 \\ 10 & 98 \end{vmatrix}$=98-110=12 y=6

Answer: There are 5 gold coins and 6 silver coins.

Method V

1. The unknowns are defined, and the first algebraic equation is formed.

$\begin{cases} x+y=11 \quad (8) \\ 10x+8y=98 \end{cases}$ -8x-8y=-88

$\begin{cases} 8x+8y=88 \\ 10x+8y=98 \end{cases}$

The equations are rewritten in a convenient form and subtracted from each other.

$\begin{cases} 10x+8y=98 \\ 8x+8y=88 \end{cases}$

2x+0=10

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x=5

x+y= 11 **is found by substituting** x **into the equation.**

5+y=11 y=11-5 y=6

Answer: There are 5 gold coins and 6 silver coins.

These methods of solving equations are not only used for systems with two unknowns, but are also suitable for solving systems with three or more unknowns. Below, methods for solving systems of equations with three unknowns are presented.

$$\begin{cases} x+y+z=1 \\ 2x+3y+4z=3,3 \\ 3x+3y+4z=3,5 \end{cases}$$

3x+3y+4z=3,5
2x+3y+4z=3,3
x=0,2

0,2+y+z=1
y+z=0,8

$$\begin{cases} 2x+3y+4z=3,3 \\ x+y+z=1 \ (2) \end{cases} \quad - \begin{cases} 2x+3y+4z=3,3 \\ 2x+2y+2z=2 \end{cases} \Rightarrow$$

y+2z=1,3

$$- \begin{cases} y+2z=1,3 \\ y+z=0,8 \end{cases}$$

z=0,5

x+y+z=1
0,2+y+0,5=1
y=1-0,7
y=0,3

x=0,2 y=0,3 z=0,5

Method 2: Substitution method for systems of equations.

$$\begin{cases} x+y+z=1 \\ 2x+3y+4z=3,3 \\ 3x+3y+4z=3,5 \end{cases} \quad x=1-y-z$$

3x+3y+4z=3,5
3(1-y-z)+3y+4z=3,5
3-3y-3z+3y+4z=3,5
z=0,5

2x+3y+4z=3,3
2(1-y-z)+3y+4z=3,3
2-2y-2z+3y+4z=3,3
y+2z=1,3

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y+2×0,5=1,3
y=1,3-1
y=0,3

x=1-0,3-0,5
x=0,2

Conclusion

By solving problems in mathematics, it is possible to enrich students' and learners' worldview, as well as expand their thinking abilities and imagination. Their understanding of the future is also developed through such activities. These algebraic methods are not only used for studying mathematics but are also applicable in learning all other sciences.

They are widely used in the study of biology, chemistry, physics, and geography, as well as in practical computational tasks. By mastering these subjects, students can, in the future, acquire the professions they desire.

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