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AN INNOVATIVE APPROACH TO TEACHING ALGORITHMS FOR PERFORMING ARITHMETIC OPERATIONS

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Annotation

This article explains all possible options of algorithms for performing arithmetic operations. The special cases in the process of their implementation are analyzed and sample examples are given.

Keywords: Arithmetic operation, addition, subtraction, multiplication, division, algorithm, numbers, room units, addition, sum, subtrahend, subtraction, multiplier, multiplication, divisor, divisible, division, tag-tag, column, angle method, remainder.

As you know, one of the main goals of elementary mathematics education is to master the algorithms for performing four arithmetic operations to the level of proficiency. In particular, in grades 5-6, this goal is partially continued. In traditional education, one of the surprise cases is that it has become a tradition to use only one of the many possible ways to work with algorithms.

I. Possible cases of the addition algorithm.

It is "accepted" to perform a typical column-type addition algorithm in the following sequence:

1) $\begin{array}{r}435\\+\\324\\\hline ?\end{array} \Rightarrow \begin{array}{r}435\\+\\324\\\hline 9\end{array} \Rightarrow \begin{array}{r}435\\+\\324\\\hline 59\end{array} \Rightarrow \begin{array}{r}435\\+\\324\\\hline 759\end{array}$

In fact, it is not necessary to start the addition from the unit room, that is:

2) $\begin{array}{l}435\\+\\324\\\hline ?\end{array} \Rightarrow \begin{array}{l}435\\+\\324\\\hline 5\end{array} \Rightarrow \begin{array}{l}435\\+\\324\\\hline 75\end{array} \Rightarrow \begin{array}{l}435\\+\\324\\\hline 759\end{array}$

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3)
$$\begin{array}{r} 435 \\ + \\ 324 \\ \hline ? \end{array} \Rightarrow \begin{array}{r} 435 \\ + \\ 324 \\ \hline 7 \end{array} \Rightarrow \begin{array}{r} 435 \\ + \\ 324 \\ \hline 75 \end{array} \Rightarrow \begin{array}{r} 435 \\ + \\ 324 \\ \hline 759 \end{array}$$

This is also possible if the sum of the numbers representing the room units is 10 or more; for example: $765 + 358 = ?$

1)
$$\begin{array}{r} 765 \\ + \\ 358 \\ \hline 13 \\ +110 \\ 1000 \\ \hline 1123 \end{array}$$

2)
$$\begin{array}{r} 765 \\ + \\ 358 \\ \hline 110 \\ +13 \\ 1000 \\ \hline 1123 \end{array}$$

3)
$$\begin{array}{r} 765 \\ + \\ 358 \\ \hline 1000 \\ +110 \\ 13 \\ \hline 1123 \end{array}$$

Here, in the first column, first the rooms of units, then decimals, then hundreds, are added, in the second column, first decimals, then units, and finally hundreds, and in the third column , first hundreds, then tens, and finally numbers representing units are added, and the results are the same. Traditionally, this is done by memorizing the 1st column form “in the mind” (“in the heart”, “remember”). And in the way we offer, there is no need to remember in different "places".

II. Possible cases of the subtraction algorithm.

A typical algorithm is executed in the following sequence:

$786 - 325 = ?$

1)
$$\begin{array}{r} 786 \\ - \\ 325 \\ \hline 1 \end{array} \Rightarrow \begin{array}{r} 786 \\ - \\ 325 \\ \hline 61 \end{array} \Rightarrow \begin{array}{r} 786 \\ - \\ 325 \\ \hline 461 \end{array}$$

In fact, it doesn't matter from which room unit the division is performed, that is:

2)
$$\begin{array}{r} 786 \\ - \\ 325 \\ \hline 6 \end{array} \Rightarrow \begin{array}{r} 786 \\ - \\ 325 \\ \hline 61 \end{array} \Rightarrow \begin{array}{r} 786 \\ - \\ 325 \\ \hline 461 \end{array}$$

3) $\begin{array}{r} 786 \\ - \\ \underline{325} \\ 4 \end{array} \Rightarrow \begin{array}{r} 786 \\ - \\ \underline{325} \\ 46 \end{array} \Rightarrow \begin{array}{r} 786 \\ - \\ \underline{325} \\ 461 \end{array}$

This is possible even if the appropriate room units of the reducer are smaller than the corresponding room units of the subtrahend, for example, in the traditional way, the crushing of one of the upper room units is done by "borrowing" as follows:

$825-476=?$

1) $\begin{array}{r} 725 \\ - \\ \underline{476} \\ 9 \end{array} \Rightarrow \begin{array}{r} 725 \\ - \\ \underline{476} \\ 49 \end{array} \Rightarrow \begin{array}{r} 725 \\ - \\ \underline{476} \\ 349 \end{array}$

In fact, it doesn't matter from which room units the subtraction is performed, it is sufficient to make the decimal notation of the denominator subtracted, i.e.

$825 = 8\cdot 100 + 2\cdot 10 + 5\cdot 1 = 7\cdot 100 + 10\cdot 10 + 2\cdot 10 + 5\cdot 1 =$
$= 7\cdot 100 + 12\cdot 10 + 5\cdot 1 = 7\cdot 100 + 11\cdot 10 + 1\cdot 10 + 5\cdot 1 =$
$= 7\cdot 100 + 11\cdot 10 + 15\cdot 1 = 7(11)(15)$

$7(11)(15)$ –it is a non-standard form of the decimal notation of a designation number 825, denoting its form written in 7 hundred, 11 decimals, and 15 ones..

1) $\begin{array}{r} 7(11)(15) \\ - \\ \underline{4\ \ 7\ \ 6} \\ 4 \end{array} \Rightarrow \begin{array}{r} 7(11)(15) \\ - \\ \underline{4\ \ 7\ \ 6} \\ 4\ \ 9 \end{array} \Rightarrow \begin{array}{r} 7(11)(15) \\ - \\ \underline{4\ \ 7\ \ 6} \\ 3\ \ 4\ \ 9 \end{array}$

2) $\begin{array}{l} 7(11)(15) \\ - \\ \underline{4\ \ 7\ \ 6} \\ 3 \end{array} \Rightarrow \begin{array}{l} 7(11)(15) \\ - \\ \underline{4\ \ 7\ \ 6} \\ 3\ \ 4 \end{array} \Rightarrow \begin{array}{l} 7(11)(15) \\ - \\ \underline{4\ \ 7\ \ 6} \\ 3\ \ 4\ \ 9 \end{array}$

III. Possible cases of multiplication algorithm.

We usually multiply two-digit numbers by the following algorithm:

$$\begin{array}{r} 34 \\ \times \\ \underline{56} \\ 204 \\ + \\ \underline{170} \\ 1904 \end{array}$$

1) $6 \cdot 4 = 24,$ write 4, memorize 2;
2) $6 \cdot 3 = 18$ and will be 20 with the 2 in memory and put it next to 4;
3) $5 \cdot 4 = 20,$ Move 0 to the left of a room above we write under 0 in the upper row and remember 2 again;
4) $5 \cdot 3 = 15$ and will be 17 with 2 in memory and write it next to 0 in the second row appropriate to the room units ;
5) Add the resulting numbers one by one.

In fact, multiplication can be done using three other possible algorithms:

1)

$$\begin{array}{lr} & 34 \\ & \times \\ & \underline{56} \\ 50 \cdot 4 \to & 200 \\ 50 \cdot 30 \to & 1500 \\ 6 \cdot 4 \to & 24 \\ 6 \cdot 30 \to & \underline{180} \\ & 1904 \end{array}$$

1) Multiply 5 decimals by 4 units and draw the result in the line down appropriate to the room units;
2) Multiply 5 decimals by 3 units and draw result in the line 2 appropriate to the room units;
3) Multiply 6 units by 4 units and draw the result in the third line appropriate to the room units;
4) Multiply 3 decimals by 6 units and draw the result in the line 4 appropriate to the room units;
5) Add the results in the form of a tag (column).

2)

$$\begin{array}{lr} & 34 \\ & \times \\ & \underline{56} \\ 4 \cdot 50 \to & 200 \\ 4 \cdot 6 \to & 24 \\ 30 \cdot 6 \to & 180 \\ 30 \cdot 50 \to & \underline{1500} \\ & 1904 \end{array}$$

3)

$$\begin{array}{lr} & 34 \\ & \times \\ & \underline{56} \\ 30 \cdot 6 \to & 180 \\ 30 \cdot 50 \to & 1500 \\ 4 \cdot 50 \to & 200 \\ 4 \cdot 6 \to & \underline{24} \\ & 1904 \end{array}$$

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IV. A special case of the division algorithm.

When dividing natural numbers by the angle method, there are problems with writing zeros in divisions in the following similar cases:

817 | 9　　　63027 | 9　　　645 | 8

56048 | 8　　　51 | 5　　　125075 | 25

To solve such problems, it is necessary to fully understand the essence of the definition of being residual. Being residual of number a by number b is to find such numbers q and r where the equation $a = q \cdot b + r, r < b$ holds. Here 3 possible cases: $a = b$, $a > b$ and $a < b$. $a,, b, q, r \in N$ or it is possible be 0. In the first case, if $a = b$,then it will be $q = 1, r = 0$.

In the second case, if $a > b$, then it will be $q < a$, $0 \le r < b$. For example, $17{:}8 = ?$, $17 = 2 \cdot 8 + 1$; $202{:}2 = ?$, $202 = 101 \cdot 2 + 0$.

In the third case,if $a < b$, then it will be $q = 0$ and $r = a$. For example, $8{:}17 = ?, 8 = 0 \cdot 17 + 8$.

Let's do the above division for case 3:

```
 817 | 9          63027 | 9          645 | 8
-81  | 90        -63     | 7003      -64  | 80
 ---              --                 --
 07               00                 05
- 0              - 0                - 0
 --               --                 --
  7               02                 5 q
                 - 0
                  --
                  27
                - 27
                  --
                   0

 56048 | 8        51 | 5        125075 | 25
-56    | 7006    -5  | 10      -125
 --               --            ---
 00               01            00
- 0              - 0           - 0
 --               --            --
  04              1 q           07
```

$$\begin{array}{rr} - & \underline{0} \\ & 48 \\ - & \underline{48} \\ & 0 \end{array} \qquad \begin{array}{rr} - & \underline{0} \\ & 75 \\ - & \underline{75} \\ & 0 \end{array}$$

Third case can be accepted as following rule " if divisible is less than divider, quotient is equal to 0 and remainder is equal to divisible ". This rule shows that, rules without mathematic meaning like: "add zero", " if we subtract two numbers, we write one zero" , "number 9 does not exist in the number 7 " are baseless.

Thus, in order to properly use the algorithms for performing arithmetic operations, it is recommended that:

1) to know the transition from the standard decimal notation of natural numbers to non-standard decimal notation;
2) to be able to write the number of units, decimals, hundreds of non-standard forms of natural numbers in parentheses;
3) to follow the rule of being residual " if divisible is less than divider, quotient is equal to 0 and remainder is equal to divisible " in order not to make a mistake when dividing by the angular method .

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