# DIAGNOSTICS OF MATHEMATICAL DEVELOPMENT OF CHILDREN

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## ABSTRACT

This article discusses the method of diagnosis and correction of the mathematical development of children using intellectual computer games.

**Keywords:** Diagnostics, correction, mathematical development of children, computer games with tests, game stages, diagnostic results.

**Diagnostics** is the identification of the level of development of children in a particular area.
The purpose of diagnosing the mathematical development of children:

- identify the level of development of elementary mathematical representations, abilities, skills of children;
- purposefully plan and organize the educational process, taking into account the level of development of children;
- timely conduct individual correctional work with children.

For diagnostics, you can use specially developed authoring techniques. You can independently compose tasks according to the program of training and development of children.
Requirements for the preparation of tasks:

1. Tasks should be within the framework of the program according to which teachers work in this age group.
2. Tasks should cover tasks from all sections of the program for the formation of elementary mathematical representations in children.
3. It is necessary to use tasks that were not used during training (similar ones can be, but with other manuals).
4. The content of tasks is important to include the use of knowledge, skills in the new conditions, situations.

To diagnose the mathematical development of preschoolers, we have developed an author's technique related to computer games. According to this technique, diagnostics are carried out in stages:

Diagnostics №1.
Test computer games by age groups are developed, tasks from all sections of the program are included. It can be used to diagnose the mathematical development of children at the end of the school year.
Diagnostics № 2.
Test computer games are developed by age groups quarterly, which allows them to be used for intermediate control.
Diagnostics № 3.
Test computer games are developed in certain sections: "Representations of the set", "Orientations with sets and numbers", "Representations of the size and form", etc. The

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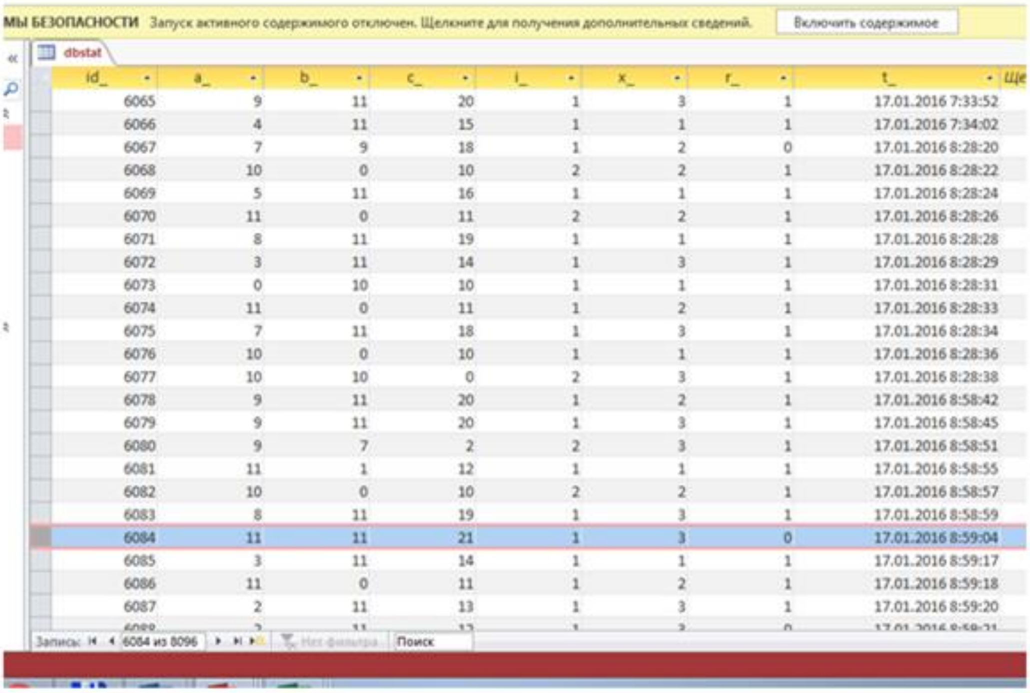
methodology for conducting tasks in each age group is described. Can be used at the end of the school year.

Diagnostics № 4.

Designed for children 6-7 years old. Features of this diagnosis:

- reduction in the number of tasks due to a three-level assessment of their implementation by children (compactness of the methodology);
- criteria-based approach to diagnostics (three-level assessment of tasks for children); allows you to evaluate not only the actual, but also the potential level of development of the child ("zone of proximal development");
- most of the tasks have a problem-play character, their implementation arouses interest in the child, reveals his cognitive skills.

All information necessary for the statistical processing of the game result is stored on the computer memory in the form of a protocol, i.e. Diagnostic results are drawn up in a table (See. Fig. 1).


МЫ БЕЗОПАСНОСТИ Запуск активного содержимого отключен. Щелкните для получения дополнительных сведений. Включить содержимое

dbstat

| id_ | a_ | b_ | c_ | i_ | x_ | r_ | t_ |
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| 6065 | 9 | 11 | 20 | 1 | 3 | 1 | 17.01.2016 7:33:52 |
| 6066 | 4 | 11 | 15 | 1 | 1 | 1 | 17.01.2016 7:34:02 |
| 6067 | 7 | 9 | 18 | 1 | 2 | 0 | 17.01.2016 8:28:20 |
| 6068 | 10 | 0 | 10 | 2 | 2 | 1 | 17.01.2016 8:28:22 |
| 6069 | 5 | 11 | 16 | 1 | 1 | 1 | 17.01.2016 8:28:24 |
| 6070 | 11 | 0 | 11 | 2 | 2 | 1 | 17.01.2016 8:28:26 |
| 6071 | 8 | 11 | 19 | 1 | 1 | 1 | 17.01.2016 8:28:28 |
| 6072 | 3 | 11 | 14 | 1 | 3 | 1 | 17.01.2016 8:28:29 |
| 6073 | 0 | 10 | 10 | 1 | 1 | 1 | 17.01.2016 8:28:31 |
| 6074 | 11 | 0 | 11 | 1 | 2 | 1 | 17.01.2016 8:28:33 |
| 6075 | 7 | 11 | 18 | 1 | 3 | 1 | 17.01.2016 8:28:34 |
| 6076 | 10 | 0 | 10 | 1 | 1 | 1 | 17.01.2016 8:28:36 |
| 6077 | 10 | 10 | 0 | 2 | 3 | 1 | 17.01.2016 8:28:38 |
| 6078 | 9 | 11 | 20 | 1 | 2 | 1 | 17.01.2016 8:58:42 |
| 6079 | 9 | 11 | 20 | 1 | 3 | 1 | 17.01.2016 8:58:45 |
| 6080 | 9 | 7 | 2 | 2 | 3 | 1 | 17.01.2016 8:58:51 |
| 6081 | 11 | 1 | 12 | 1 | 1 | 1 | 17.01.2016 8:58:55 |
| 6082 | 10 | 0 | 10 | 2 | 2 | 1 | 17.01.2016 8:58:57 |
| 6083 | 8 | 11 | 19 | 1 | 3 | 1 | 17.01.2016 8:58:59 |
| 6084 | 11 | 11 | 21 | 1 | 3 | 0 | 17.01.2016 8:59:04 |
| 6085 | 3 | 11 | 14 | 1 | 1 | 1 | 17.01.2016 8:59:17 |
| 6086 | 11 | 0 | 11 | 1 | 2 | 1 | 17.01.2016 8:59:18 |
| 6087 | 2 | 11 | 13 | 1 | 3 | 1 | 17.01.2016 8:59:20 |

Записи: 6084 из 8096 Поиск

Fig. 1. Diagnostic results.

To summarize, it is necessary, individually, i.e. by “page” (that is, to reveal the level of development of one particular child).

To determine the level of development of children, it is necessary to develop a system of points.

Based on the diagnosis of the mathematical development of children, it is necessary to carry out individually-corrective work.

**Correction** is a set of pedagogical measures aimed at weakening (i.e., partial correction) or correcting deficiencies in the mathematical development of a child. Timely diagnosis of the development of pupils of the group allows the teacher to outline ways to improve learning outcomes. The teacher should build correctional work so that children with a low level of mathematical development are pulled up to medium, with an average - to high, and work with a more complex program with children with a high level of development.

Correctional work is carried out, as a rule, individually or with a subgroup of children. The association of children into subgroups is carried out taking into account the assimilation or insufficient assimilation of a specific program task.

For a child to successfully master math software problems, the joint efforts of teachers and parents are required. Among parents should be propaganda of entertaining mathematical, artistic and cognitive materials, various educational games for children. Parents should be familiarized with the results of the diagnosis of the mathematical development of their child, to contribute to its further development.

Purposeful systematic correctional work allows to increase the level of mathematical development of children.

As an example, we present the process of diagnosing a child's mathematical development through a computer game called "Intellectual Cards" [3] designed to teach children 5-7 years to add and subtract two-digit numbers. The content of this game technology is as follows:

Cards are displayed on a screen, which is more complicated than simple $a+b=c$, or $a-b=c$ illustrated with one of the visible components and components left open (in the form of a window $a+b=x,\ a-b=x,\ a+x=c,\ a-x=c,\ x+b=c,\ x-b=c$ ). When a child writes a number on a window (instead of an unknown component), the program responds to the choice of whether it is right or not and replaces the screen card with another (Figure 2);

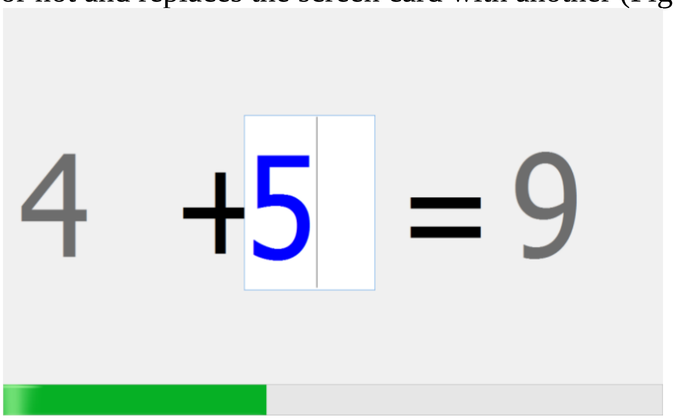

Figure 2. Computer game interface "Intelligent Cards"

The child completes one of the rounds by solving 10 of the examples given to him. Sample cards are exchanged on the screen until the correct answer reaches 10;
The mentality of this card game is manifested in the following areas:

1. All examples that require a child to perform $0+0=0$ or $0-0=0$ hundred insertion and subtraction operations are simplified, but not in a consecutive manner (or one of a series of examples, from one of the visible examples to the first 60 the sample will be placed in the current database and will be randomly selected and displayed from these 60 instances), placed in the intended number of equity (for example), which is offered to card mode;
2. There is never a case when the cards on the screen are lost for minor children. Cards with examples such as $8+[\ ]=5,\ [\ ]+9=2,\ 6-7=[\ ]$ will never be displayed;
3. In each case that is displayed, the action gestures, the values of the known components in the equation, and the location of the unknown component vary based on the randomness law;
4. The child is taken out of the database five times in a row and transferred to another database known as "2-Day", which does not return to the current database until 2 days later

(not displayed). This will allow new, more sophisticated examples to appear on the screen instead of mastered and now child-friendly examples;

5. If the child returns to the current database for the first time after 2 da, if the child does it correctly (the answer is not forgotten in 2 days), the example will be removed from the current database and transferred to the third base, which is called "2 weeks", cannot be returned to the current database until 2 weeks later. Otherwise, if the child cannot solve the example displayed on the screen 2 days later, the sample will remain in the current database;

6. Each instance that is removed from the current database will be replaced by another generated instance (that is, the current database will be filled to 60).

7. The child's reaction to each screened instance is evaluated by the program by scoring and evaluating the sample, and the data is stored in a log file (Figure 1);

This intellectual card game develops abstract thinking in young children and prepares them for the process of solving textual problems.

This game was tested in children of 5-5.5 years of age who had different interests in computer games. During the test, 20 cards were issued to add and subtract numbers. Statistical processing and analysis of test records shows that the majority of children achieved an average of between 250 and 300 samples per day, the number of correctly solved examples in the samples $a+b=x$, $a-b=x$, $a-x=c$ is 88 - 89% and higher than the total number of instances of this type, it was found $a+x=c$ $x+b=c$ that 85 to 86% of the cases were spent, even though most of the examples were very short - only 1-2 seconds.

In addition, it was observed that almost all examples of adding and subtracting the same numbers were performed correctly. For example, it is found that development is much lower - 55 - 56%. Among these examples, there are some that have not been answered correctly. It can be concluded that given the fact that children are struggling to solve specific examples from the above 6 types of examples, it is necessary to pay more attention to teaching such examples $x-b=c$ and to create a program to teach these types of examples. Statistical analysis shows that the majority of children spend an average of 2 to 3 minutes to correct 10 of the examples provided by intellectual cards. It has been reported that many children have been shown to be constantly changing patterns on the cards, repeating the examples almost unnoticed, the role of the unknown component in the expressions, and the constant change of gestures. Diagnosis of the child's mathematical development through the computer game "Intelligent Cards" is shown in the following statistical analyzes. The results shown in the record in Figure 1 are summarized in the table below

| In the examples the location of the unknown | The number of correct answers | In % | Incorrect number of responses | In % | The total number of examples |
|---|---|---|---|---|---|
| $a+b=x$ | 1363 | 86,42993 | 214 | 13,57007 | 1577 |
| $a-b=x$ | 740 | 81,58765 | 167 | 18,41235 | 907 |
| $a+x=c$ | 1397 | 86,39456 | 220 | 13,60544 | 1617 |
| $a-x=c$ | 684 | 89,41176 | 81 | 10,58824 | 765 |
| $x+b=c$ | 1477 | 83,8252 | 285 | 16,1748 | 1762 |
| $x-b=c$ | 793 | 54,01907 | 675 | 45,98093 | 1468 |
| Total | 6454 | 79,71838 | 1642 | 20,28162 | 8096 |

The variation series from these results is as follows:

| | $x_i$ | $y_i$ | $z_i$ |
|---|---|---|---|
| 1 | 1363 | 214 | 1577 |
| 2 | 740 | 167 | 907 |
| 3 | 1397 | 220 | 1617 |
| 4 | 684 | 81 | 765 |
| 5 | 1477 | 285 | 1762 |
| 6 | 793 | 675 | 1468 |
| Total | 6454 | 1642 | 8096 |

Where $x_i$ - number of correct answers, $y_i$ - number of incorrect answers. Total number of examples given.

$\bar{x} = \frac{1}{n}\sum_{i=1}^{6} n_i x_i$ the sample mean $\bar{x}$ (the average number of correct answers) and the sampling mean $\bar{x} = 1043{,}47$ (the average of the number of incorrect answers), and the sample mean $\left( D_r = \frac{1}{n}\sum_{i=1}^{n} n_i (x_i - \bar{x})^2 = 1043{,}47 \right)$ of the sample $\bar{y} = \frac{1}{n}\sum_{i=1}^{6} n_i y_i$ (the total given by the formula) find $\bar{y}$ the mean of the sample number) and the corresponding sample variance.

x (the number of correctly found samples) and z (the total number of samples) are normally distributed, with their dispersions known. These collections have the same amount $n = 21$ of sampling options, and their variants accordingly $x_i$ and $y_i$ in proportion. We test the hypothesis $H_0 : M(\bar{x}) \neq M(\bar{z})$ that two sets of normal sets $\alpha = 0{,}02$ are the same as the conjunctive hypothesis (in the case of the same size associated variables).

We will make the following determinations: $d_i = z_i - x_i$ – the variance of the same number of variants, and calculate the value of the following results:

$n_i$ : 1 2 3 4 5 6

$d_i$ : 214 167 220 81 285 675

$\bar{d} = \frac{\sum_{i=1}^{12} d_i}{n}$ – we calculate the average of the variations of the variants of the same number: it is 78.19.

Calculate the average squared deviation from the formula $s_d = \sqrt{\frac{\sum_{i=1}^{n} d_i^2 - \frac{[\sum_{i=1}^{n} d_i]^2}{n}}{n-1}}$ –:

$s_d = 163{,}87$

The observable value of the criterion $T_{kuz} = \frac{\bar{d} \cdot \sqrt{n}}{s_d} = 2{,}18$

Thus, we can conclude that with a reasonable approach and observing the necessary conditions, computer games are an effective means of intensively forming subject knowledge and skills, as well as socially significant personal qualities of preschool children. In this case, the negative impact of the computer with the competent organization of the process can be minimized. The main positive value of computer games lies in the rich, diverse conditions of gaming activity, which allow achieving educational goals in the most effective and attractive way for children.

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