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Impact of online simulators on primary school children's visual memory development

Roza Valeeva[a,1], Elvira Sabirova[a], Liliia Latypova[a]

[a]*Kazan federal university – Kazan (Tatarstan, Russian Federation)*

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Abstract

Modern society needs thoroughly developed individuals ready to enrich material and spiritual culture of community. Therefore, the creation of favorable conditions for maximal revealing and development of learner's abilities, growth of one's individuality and prospects for self-realization is increasingly becoming of great importance. It is memory that plays the leading role in this process. Memory is a very complex process that includes getting, keeping and repetitive using of information. Memory lies at the heart of human abilities and it preconditions learning, acquiring of knowledge, formation of skills and abilities. Development of visual memory is one of the most actual problems considering the fact that the students at school are given a great amount of new information and not much attention is paid to the development of ability to memorize information. Organizing purposeful work on memory development is a crucial task. The basic task of memory development is the development of school children's visual memory. It considerably helps to increase education quality to fulfill the main tasks of education. In this regard there is a need to look for effective means for visual memory development. The purpose of this study is to reveal effectiveness of online simulators in the process of primary school children's visual memory development. In the course of the study the following methods were used: theoretical analysis of pedagogical and methodological literature; methods of checking and diagnostics (tests, observation); pedagogical experiment that helped to show effectiveness of online simulators in the development of primary school children's visual memory.

KEYWORDS: Online Simulators, Development, Visual Memory, Primary School Children.

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1. Introduction

1.1 The Importance of the Issue

Memory is one of the basic human abilities and it conditions learning, acquiring of knowledge, formation of skills and abilities. Memory is the most important function in life as long as it takes part in every action that a human performs every day (Bulgakov, 2014). Exploring human memory was the subject matter of science and philosophy during thousands of years and became one of the main issues of interest for modern pedagogics and psychology (Bjorklund & Sellers, 2014; Schneider & Ornstein, 2015).

The German philosopher H. Ebbinghaus (Ebbinghaus, 1913) devoted many years of his life to studying memory and made interesting conclusions. He started experimental studying of memory and summarized his findings in the work "About memory" going beyond the limits of sensory processes. Ebbinghaus discovered the forgetting curve meaning that during several days of learning some information, people memorize only a little part of the things learnt. In particular, during the first 24 hours people remember about 50% of the information learnt; after 48 hours there can be recollected 30%, and after a week only 3% of all information learnt several days ago.

Human mind can keep the amount of information equivalent to ten billion encyclopedia pages. But memory is not the ideal system of storage. Although human memory is often compared with the volume of computer memory, the difference lies in the way of retrieving of the saved information or files. Computer restores a file without any changes, no matter when it

[1] corresponding author - email: valeykin@yandex.ru

was saved; whereas reminiscences recalled from human memory can be changed by many factors. This ability to change memories can go so far that subconsciously would generate false recollections. Such ability is more often the characteristic of children than grown up people. Though memory doesn't have exact copies of events as computers do, still it is a reliable system that helps to remember (Papert, 1989).

Memory is a very complex process that includes getting, keeping and repetitive using of information (Talysina, 1997). As for the place of memory, there is no definite physical location where it can be situated, it exists in various parts of brain.

According to definition of J. Piaget, memory is a set of information that is acquired by brain and that influences human behavior (Piaget & Inhelder, 1973). A.V. Petrovsky (1997) considers that memory is keeping and further reproducing the individual's own experience.

V.G. Krysko (2001) defines memory as a process of imprinting, saving and reproducing of what was reflected, done and experienced.

Smirnov (2002) proved the dependence of memorizing productivity on character of activity in which it is done. As a result of his research there were thoroughly explained characteristics and age differences in relation to intentional and unintentional memorizing.

According to L.S. Vygotsky's concept of memory, the higher forms of human memory meaning the process of active memorizing with the help of signs as the other forms of behavior appear in socialization of people (Vygotsky, 2005). Historical development of a human led to using the word as a sign that helps marking in mind the memorized things.

Development of memory is one of the actual problems of primary education (Kail, 1990; Bruck & Ceci, 1999; Schneider & Ornstein, 2015). Primary school students are given a great amount of new information, but sufficient attention is not paid to the development of ability to memorize information. Memory development goes independently according to definite order. It begins first with recognition process formation, then reproduction and in the end the selectiveness of memory is formed (Lapp, 1972). It is proved that memory gets better in the process of fulfilling certain exercises (Tihomirova, 1998).

The basic task of memory development is the development of school children's visual memory. It helps increase the quality of education. Visual memory consists of human's brain ability to keep and show the result of the earlier visual perception. Information that can be visually imagined by children is as a rule easily memorized and recollected back. According to researches, up to 80 % of perceived information goes through the eyes, which means visual memory is the most important aspect of education in primary school (Buss et al., 2018).

The need in special researches in this field is justified by numerous attempts of various authors to accentuate their vision in solving this problem (Zinchenko, 2002; Repkina, 2009; Semenova & Sidorina, 2016).

The ability to create new memories, to keep them during some time and recollect them when they are needed helps us learn and interact with surrounding world. In modern pedagogy and psychology, the issue of visual memory formation in children is very critical. Deficiency of visual memory practically stays unrevealed until a child comes into learning activity (Simmering, 2012). Academic problems that are sometimes considered as laziness or low IQ can be caused by problems with visual memory.

It is known that children easily memorize everything that is bright, colorful, unusual, all things that evoke strong emotional reaction. More often those are games. But they are intended for complex development and represent difficulty in observation process for qualitative visual memory development during long period.

It is supposed that visual memory development of primary school children will be more effective if at this process online simulators are used.

1.2 Aims of the Study

1. to reveal possibilities of online simulators for developing primary school children's visual memory;
2. to describe the development of primary school children's visual memory in the process of using online simulators.

2. Materials and Methods

2.1 Research methods

The following methods were used: theoretical analysis of pedagogical and methodological literature; methods of checking and diagnostics (tests, observations); pedagogical experiment that helped show the effectiveness of online simulators in developing primary school children's visual memory. We made a review of online simulators that are aimed at primary school children's visual memory development (B-Trainika, Wikium, BrainApps, Boostbrain).

2.2 Research Base of the experiment

The research was conducted in Kazan (the Republic of Tatarstan, Russian Federation). The sample group of the study included 32 children aged 8-9. Children were divided equally between 2 groups: 16 of them were in Group 1 and 16 in Group 2 accordingly. Group 1 worked with online simulators, group 2 did not work with simulators.

Test tasks were intended to reveal visual memory development level in accordance with criteria: volume of visual memory (amount of memorized material that is measured in operational memory units), rate of memorizing (fastness), exactness of reproduction (characterized by difference between accepted information and information "at reproduction point").

2.3. Stages of the Research

The study was carried out in three stages: at the stating stage children from 1st and 2nd groups were offered test tasks to reveal visual memory development level by means of methods "10 pictures" and "Complex figures". Diagnostics was carried out individually with every child. The forming stage was intended to develop visual memory with the help of online simulators (group 1). At this stage we made a review of online simulators. At the control stage we held the recurrent test tasks to reveal visual memory development dynamics (groups 1 and 2).

2.4. Methods to reveal the level of the visual memory development

To reveal the level of visual memory development in primary school children we used the following methods: "10 pictures" and "Complex figures".

The purpose of the "10 pictures" method by L.M. Shipitsina is to define the level of visual memory development.

Below is the implementation of the method.

A child was offered to have a look at a page with 10 pictures within 10 seconds' time. After removing the page from visual field a child had to name those pictures from memory. The more pictures were remembered and named by the learner, the higher is one's visual memory level.

Processing and analysis of the results.

The results were processed on the number of pictures named by the child:

High level - 8 and more.

Middle level - 5-7.

Low level - 4 and less.

Diagnostics was carried out individually with every child. Instructions were adequately accepted and understood by them. Almost all children approached the task in a responsible way, doing their best to memorize pictures.

For more reliable results of the experiment, we used "Complex figures" by D.Vexler - the additional method to estimate children's visual memory level.

The purpose of this method is to define visual memory development level.

Equipment: stimulus material, sheet of paper, a pencil.

Below is the implementation of the method.

Four pictures were offered to a child who had to look at every picture during 10 seconds. Then a child had to reproduce those pictures on the sheet of paper.

Processing and analysis of the results:

1. Two crossed lines and two flags -1 point;

correctly placed flags -1 point;

correct angle in crossed lines - 1 point.

Maximum evaluation for this task: 3 points.

2. Big square divided into 4 parts by 2 lines -1 point;

four small squares in a big one -1 point;

two intersecting lines and 4small squares -1 point;

four dots in squares -1 point;

accuracy in proportions -1 point.

Maximum evaluation for this task: 5 points.

3. A big rectangle with a little one inside -1 point;

all tops of internal little rectangle are connected with tops of big external rectangle -1 point;

little rectangle is exactly placed in big one -1 point.

Maximum evaluation: 3 points.

4. An open rectangle with the correct angle at every side -1 point;

the center, left and right sides are reproduced correctly -1 point;

the figure is correct with the exception of one incorrectly reproduced angle -1 point.

Maximum evaluation: 3 points.

Maximum result: 14 points.

High level - 10 or more points.

Middle level - 9-6 points.

Low level - 5-0 points.

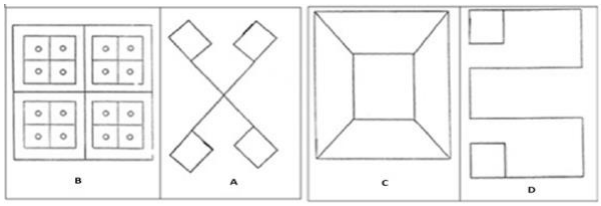

Figure 1 - Stimulus material.

2.5 Review of online simulators aimed at visual memory development of primary school children

1) Memory matrixes.
Game field represents a matrix with a net of squares. Some squares are painted. It is needed to memorize positions of painted squares and after closing the pattern, it should be recreated by pressing on the right squares. With every right answer the matrix grows; the same happens to the painted squares – their number

increases. With the wrong answer matrix becomes smaller.

2) "Find a pair" game.

Game rules are simple: it is needed to open at once 2 cells of the table, trying to find similar pictures. As soon as all the pictures are opened, game is over. This game is a memory test: the program notes the time spent on the game.

3) N-backwards.

In this task children work with sequence of numbers, letters or pictures that are shown one by one at every interval of time. In the simulator attention should be paid on the condition of passing the level that is indicated at the beginning: "It is needed to remember steps …" and the number of steps is shown. At the start it is 1 step (1- n) – the user is expected to make a positive reply when the current element matches with the previous one. At the complexity "2-n" there is expected a reply when the current element matches with the one that was two intervals ago.

4) Finding changings.

On the monitor there is shown a set of colorful elements that are needed to remember. After given time for memorizing, the initial set is replaced by a copy with one wrong object. The task is to find it. The order of pictures' position can change.

5) Camera Mind.

Simulators represent a game field where circles appear. First, there appear 1 circle, its position should be remembered and clicked. Further there goes transition to the next level and on the field there would be 2 circles, it is needed to click on the circle that was not on the previous level and remember the position of 2 circles. And so on. It is needed to remember as much as possible. (Low level of visual memory -10 circles, middle – 20 circles, high - 40 circles).

Recommendation or clue: it is easier to remember the position of circles if in your mind you draw figures that are associated with them, for example, numbers, geometrical figures, animals, trees and so on.

These simulators are represented in two variants: the first – white circles on the black background, the second – multicolored circles on the black background. Game with colored circles is more interesting for primary school children and it is easier to remember when comparing with white circles.

6) Find differences.

The user is offered to compare 2 similar pictures or things with some slight differences (on one picture there is some object and on another one it is absent, colors of elements are different, their size are different and so on). It is needed to find and point out all differences.

7) Game with numbers.

On the monitor there appear cells, by their side there is a picture (a cat, a candle, a plane, etc.). When pressing the "start" button, all cells are filled with various numbers. It is needed to remember number at every picture (20 pictures in total), and then press the button "further". On the monitor there appear cells with pictures in chaotic order. It is needed to click input box near the pictures and type the remembered numbers.

In a very short time of 1 second it is needed to remember several numbers, and then randomly show those positions where they were previously located. Numbers should be shown in ascending order, for example, 1,3,7,9. The final result will be shown when 10 guesses are made (the bigger number appears on the screen, the more mistakes were done). Therefore, learners have to strive to get the minimal number.

Visual memory develops in close connection with other kinds of memory, thinking, perception, attention, etc. There are many sites with online simulators intended for memory development, its kinds and other functions. We considered the most popular and convenient sites. These sites demand registration, after which on the user's account or profile all information will appear. Firstly, users are offered to pass a test to define visual memory development level and then according to test results there will be given a program of further lessons. Next one can have a daily program that takes no more than 15 minutes (3-5 simulators), also there can be chosen a definite skill that is needed to be developed using simulators.

Most simulators do not give statistics for long period that would have shown changes in memory development. The sites with simulators that are described further do not have such deficiency. They offer a systemic approach that develops human brain in general and improves memory in particular.

1. B-Trainika.

All simulators of this site represent online games that are aimed not only at improvement of various psychological functions of brain but also in their turn they are very entertaining There is a chance to choose certain skills and abilities for self-development. Here are three simulators for visual memory. "Path of Ninja", "Numismatist", "Astrologer".

Simulator "Path of Ninja".

On the game field divided into the definite number of squares some cells open for a short time. It is needed to remember them and show in random sequence. The higher the level, the bigger and the more complex is the picture.

Rules of the game are the following:

- remember the position of light tiles;
- when tiles turn upside down point out each of them;
- no mistakes are permitted.

Recommendation or clue:

Try to remember not the position of all squares, but a form of figures that they construct. So, it will be easier to repeat their forms.

The game is called like this because of the legend about training future ninja. On the stone there were placed several objects, those objects were covered with a cloth, then the cloth was removed for a short time so that the students could remember the objects

seen. The task was to name all objects. Years of training gave the ability to recite the text to a word after just one reading.

Simulator "Numismatist".

During the game it is necessary to compare in a short time various coins of different countries.

Rules of the game are as follow:

- remember the denomination of a shown coin and press the button "Further";
- point out matching of a new coin denomination with previously shown coin denomination;
- choose the needed number of right answers during the given time;
- on more complex levels there will be needed to remember 2 or more previous steps.

In this simulator, there should be paid attention on conditions, needed to pass the level, which are indicated at the start. One of the conditions: "It is necessary to remember … steps" – and the number of steps is indicated. At the beginning it is 1 step, it means that there should be compared the denomination of current coin with the denomination of the previous coin shown 1 step ago. If it is needed to compare 2 steps ago, then there should not be compared with the previous coin but the coin that was before the previous one.

Simulator "Astrologer".

For a short time a certain number of stars are opened before a child. It is necessary to manage counting them and correctly indicate their number. With every achieved level the number of stars will grow, so it will be needed to unite them into groups. Besides, with every new level there is a chance to make a new discovery, exploring nebulosity, planets and star clusters.

2. Wikium.

At the heart of Wikium simulators there are methods of renowned neuropsychologists who proved their effectiveness during many experiments and scientific papers. The user does introductive testing to check the current level of memory, attention and thinking. Further there will be formed the personal program of development. Daily program development includes warming up and training.

Simulators of visual memory: "Matrixes of memory", "Signal lamps", "Secret room" and so on. They all follow one principle: it is needed to remember the order of actions and repeat it.

3. BrainApps.

BrainApps in automatic mode offers training program with optimal workload. It is a set of unique and effective simulators with psychologically proved results. At the core of this service are simulators that are advanced versions of known exercises and puzzles used in 19-20 centuries.

Games aimed at visual memory development:

"Diamonds" – on the game field the cells light up in the definite order. It is needed to remember their order and repeat it.

"*N2 backwards"* – there is given the sequence of numbers, it is needed to remember all the sequence and compare number on the last card with the number on the previous one; the answer is given by buttons "yes"/"no".

"Fast comparison" represents a set of pictures, it is needed to remember the previous picture and compare it with the current one, responding if it is repeated or not.

4. Boostbrain.

This site also has simulators that include at their core such principles as matrixes of memory, step back, games with numbers. We considered the ones that were not used on other sites:

"Lost symbol" game.

Purpose of the game is to remember the position of symbols and then to point out the missing one. On the square with 4 cells there are 4 symbols that disappear in 2 seconds' time, then there appear only 3 of them, and one cell is empty. On the lower part of the game field there appear 4 symbols, it is needed to find among them the one that disappeared in the square. On the more advanced levels the amount of cells increases up to 6 and further up to 9.

"Random" game.

The game runs for a short time, only 60 seconds - when time is over, the game stops. For this period it is needed to try to get as many points as possible. One has to remember the position of numbers and then to point them out in order. Numbers disappear after pressing the number "1", but this number stays. The game starts with three numbers and according to complication there is added one more number, and so on up to 9 (therefore the score increases after passing the level), if there is mistake in sequence of numbers, then the game comes one stage back decreasing the amount of numbers necessary to remember. When a learner achieves the level with 9 numbers, the amount of numbers stops to change and every time it is needed to remember the position of numbers from 1 to 9.

3. Results

3.1 The stating stage of the experiment

During the study it was noted that some children whispered the kinds of pictures, compensating in this way the lack of visual memory by auditory memory as another skill. Taking this into account it becomes obvious that there is no visual memory sufficiently formed in this age category, despite the fact that their level of memorizing was not bad.

Groups	10 pictures Levels			Complex figures Levels		
№	Low %	Middle %	High %	Low %	Middle %	High %
1	44	56	0	44	56	0
2	31	63	6	25	56	19

Table 1 - Stating stage.

Interpretation of results revealed that visual memory in more than a half of the children does not correspond to this age memory volume norm in average consisting of 7-8 illustrations. These results allow to conclude that visual memory of learners is lower than average and it should be developed.

Also, considering the results of diagnostics there can be seen such peculiarity in primary school children as remembering bright and colorful other than uninteresting material. Almost all learners recollected colorful pictures of ball, house and duck. And only several learners could recollect pictures of spectacles and hammer that do not attract attention because of their unnoticeable color tones.

Interpretation of results showed that the most part of learners remembered really well and reproduced picture "C" – the picture consisting of simple figures and little amount of elements was the easiest one for children.

There are those learners who did not remember picture "D". During conversation it was found out that this picture seemed too complex for some learners and that was why the learner did not try to memorize it, and another learner couldn't remember the picture when tried to reproduce it on paper.

For the picture "B" more marks are given - 5. None of the learners could reproduce it with maximum accuracy. Some learners could not manage with proportions, the others forgot to draw small elements, some of them, on the contrary, missed a big square.

Comparing the results of remembering the "A" picture, it was clear that this task was not simple. Most mistakes were made by incorrectly placed flags and wrong angles in the intersection of lines.

3.2 Development of visual memory

Before the start of work with computers there was a meeting with the school doctor who analyzed medical documents concerning the health of children and in particular their eyesight. All the participants of the 1st group did not have ophthalmic diseases.

Further there was an introductory lesson where learners came with their parents. At this lesson the work structure, its purpose and expected results were explained in detail. Together with parents and teacher there was made a schedule convenient for everyone. Then, everyone was introduced to such modern means of developing learner skills as online simulators, told about possibilities of these game simulators, about their advantages in comparison with traditional didactic games. Also children were instructed about safety measures and rules of work with personal computers. After this every learner got the manual "Rules of work with computers", which included exercises on gymnastics for eyes.

For the lessons there were chosen two most interesting and popular simulators: "Matrixes of memory" and "Camera mind" (the version with colored circles), that develop visual memory in basic criteria of its estimation: volume, rate of memorizing and accuracy of reproduction.

These simulators do not limit learner in time and they stop only if the mistake is made. Choice of games without count of time is based on psychological peculiarities of children. Limitation in time causes emotional stress and increased feeling of responsibility, which lowers brain activity of a learner. At every lesson learners played during 15 minutes on the first simulator, and then for 15 minutes on the other one. Between the first and the second simulator learners did gymnastics for eyes. Such structure of lessons was organized because at junior age it is very difficult to keep attention of children on one subject, therefore a change in activity is needed. Thanks to such structure children have increased interest and ability to learn.

Online simulator "Matrixes of memory".

Purpose: development of accuracy and volume of visual memory.

This game simulator demands to remember positions of painted cells and after, it is needed to recollect them from memory. Game field represents a blue background where a block consisting of definite amount of cells appears (the amount of cells depends on the passing game level and it becomes more complicated – the 1st level is represented as a block of 9 squares, 3 of them are for remembering; the last level has 54 cells, and 12 of them are for remembering), for a few seconds (1-2) the squares that are needed to keep in mind are turned upside down, after that they get closed. Further in voluntary order it is needed to press the needed cells. If the cell is chosen correctly, it opens, and if all the cells are guessed correctly, there goes the transition to the next level.

And if the cell is chosen incorrectly, the game stops and it starts again.

The whole game can be conditionally divided into 3 stages:

1st stage – initial (easy);

1st-2nd level - 3 of 9 cells;

3rd-4th level - 4 of 12 cells;

5th-6th level - 5 of 16 cells;

2nd stage-middle;

7th-8th level - 6 of 20 cells;

9th-10th level - 7 of 25 cells;

11th-12th level - 8 of 30 cells;

13th-14th level - 9 of 35 cells;

3rd stage – levels of higher complexity;

15th-16th level - 10 of 42 cells;

17th-18th level - 11 of 48 cells;

19th-20th level - 12 of 54 cells.

Lesson observations were written into table intended for controlling the process of simulator usage. There were noted lessons and level of the game that was approached but still not passed by learners by the end of lesson.

So, the best game result showed one learner having passed 16 levels and having found 10 painted cells out of 42. Since the first lesson all learners many times passed the same levels because it was difficult for them to remember the amount of more than 4 cells. This helped them to memorize results and every time the actions of learners became more automatic.

Learners were in a very optimistic mood, despite of frequent mistakes they did not get upset and immediately started playing again. There were learners whose main mistake in many cases was haste. They wanted to see and to know so much what would be at the more complicated levels that even knowing the positions of needed cells they accidentally pressed the wrong cell. There were those who had difficulty with concentration and they constantly got distracted - that's why they could not remember the painted cells and for a long time could not pass even easy levels. But by the 3rd lesson there appeared competitiveness in children in relation to classmates and they started to show good results.

In general all children achieved good results. The game increased their motivation to succeed. Children were interested in how to remember more cells for such a short time. They were glad to see their achievements and they shared their impressions with each other.

Simulator "Camera Mind".

Purpose: development of visual memory.

Simulator represents black background where colored circles, which have to be kept in memory, appear. At the beginning there appears one circle, its position has to be remembered and it should be clicked. Further there goes transition to the next level and there will be two circles, it is needed to click the circle which has not been on the previous level and it is needed to remember position of these two circles. And so on. It is needed to remember as much as possible. Simulator does not limit the learner in time.

Instead of classical simulator with white circles, there was chosen the version with colored ones taking into account perception peculiarities of primary school children. For children a bright game field is more interesting than space with unremarkable color tone, and children easily remember circles of various colors.

The best result was shown by one learner who managed to remember 21 circles. Children liked this game very much. They played it with great interest and watched their own results. At the first lesson they remembered 6-7 circles on average, and further learners had difficulties in finding a new circle that appeared on the monitor last.

Passing further, learners comparatively longer looked for the needed circles; they used their own memory to the full and analyzed positions of all elements. In memorizing larger amounts of circles the recommendations helped that it was easier to remember if one imagines the positions of circles as a kind of some object: circles clustered in the shape of stars, of a house and so on.

It should be noted that in a process of game on this simulator, visual memory development was not traced at every lesson. There were lessons when results of some learners achieved higher levels, though at the next lesson this result was not improved but on the contrary it became lower. Children explained it by the fact that considering too many circles they lost their self-confidence and thinking that they would not get better results made them give up. But when they saw their classmates achieving records they started the game with new enthusiasm.

The work with the first group, in general, consisted of 30 lessons, each lesson lasted 30 minutes. At the initial stage children had difficulties in remembering a large amount of elements and they advanced very slowly. By the end of the forming stage all of them fulfilled their tasks actively and with great success.

3.3 Controlling stage of the experiment

To define the effectiveness of work done on the forming stage of the experiment the controlling experiment was carried out. At this stage, there were applied the same diagnostic methods as the ones applied at the stating stage, but there was used another set of pictures. The controlling diagnostics was carried out with children of the 1st and 2nd groups.

In diagnostic process there was revealed data about the level of visual memory development given in Table 2.

Groups	10 pictures Levels			Complex figures Levels		
№	Low %	Middle %	High %	Low %	Middle %	High %
1	0	50	50	0	56	25
2	19	56	25	6	69	25

Table 2 - Controlling stage.

There is no doubt that the level of visual memory development in the 1st group is considerably higher than in the 2nd one.

Learners of the 1st group showed sufficient volume of visual memory, its accuracy and good rate of memorizing.

It is obvious that the level of visual memory in the 1st group became higher in comparison with data revealed at the beginning of the experiment. There were no children with the lowest indexes of visual memory; the indexes of both methods were high.

5. Discussion and Conclusions

Psychologists proved that memory advances in the process of certain exercises. As a result of work with similar intellectual operations corresponding neural communication develops and brain starts fulfilling the demanded task more effectively.

Visual memory plays crucial role in children's general development. It helps acquire skills necessary for success at primary school. Children with insufficient visual memory can have problems with learning.

Development of visual memory with the help of online simulators is one of the available and effective ways. You only need a smartphone with internet connection, and today it is not a problem.

Online simulator is an interesting and convenient way to develop not only visual memory but all kinds of memory, and also perception, reasoning and attention.

Through possibility to watch the dynamics of one's own success, displayed statistics and competitive spirit, the uninteresting and boring lessons intended to develop visual memory will become a captivating daily game. As a result there will be noticeable positive changes.

Online simulators help children not to do boring and tiresome exercises but have school lessons only 15-20 minutes long in a form of interesting online games. Tasks in online simulators basically are aimed to fulfill the following actions: memorizing squares in the matrix of memory; looking for pair of pictures; remembering previous "step" or a "step" that was several intervals ago; looking for differences between two pictures; finding a new element on the screen, etc.

We organized a pedagogical experiment with the aim to reveal online simulators usage effectiveness in the process of primary school children's visual memory development.

The following criteria indexing primary school children's visual memory development level are taken: volume of visual memory (amount of memorized material measured in operational units of memory); rate of memorizing (fastness); accuracy of recollection (characterized by difference degree between accepted information and information "at reproduction point").

Review of online simulators' influence on visual memory development of primary school children showed that there are many sites with online simulators for developing any kinds of memory and other functions. We examined the most popular and easiest of them (B-Trainika, Wikium, BrainApps, Boostbrain).

We chose two most interesting and simple online simulators: "Matrixes of memory" and "Camera Mind" for the children of the 1st group. The number of lessons and their length were defined in accordance with the recommendations of ophthalmology doctors - 2 lessons a week, each 30 minutes long. The learners used these simulators during 15 weeks.

As a result of the controlling stage in two groups, it was found out that the level of visual memory development in the 1st group children became higher than in the second group. Learners of the 1st group showed high and middle level, there were no children with low level. In the 2nd group the students have considerable changes.

Thus, the use of online simulators helped develop visual memory of students, children became able to keep in memory great amounts of visual images, reproduce images more exactly and remember material in a short time. These results prove that the primary school children's visual memory development will be effective if online simulators are used.

Recommendations

Materials and results of the study can be used by teachers of primary school, parents of primary school children and school administration to organize learning activity of children.

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