USE OF ONLINE SIMULATORS FOR THE FORMATION OF PRIMARY SCHOOL LEARNERS' COMPUTING SKILLS

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Abstract: *The article offers an overview of existing online simulators, such as LearningApps, Liveworksheets, Wizer.me, OnlineMSchool.com, http://miksike.net.ua, for the formation of computing skills of primary school children; it provides the analysis of advantages and disadvantages of their use. The educational online environment Miksike (http://miksike.net.ua) operating within the educational project Miksike in Ukraine is an effective means of developing computing skills in primary school learners thanks to the Pranglimine subsystem created in this system. These simulators not only develop the skills of oral calculations, but also give the opportunity to actively communicate to participants from different European countries (Estonia, Lithuania, Latvia and Slovenia).*

Thus, primary school teachers are offered a set of ready-made ICT tools for learners to acquire numeracy competence as a key one. At the same time, the question arises as to the approximation of the content of tasks for the formation of students' strong numeracy skills to the content of the tasks of a particular lesson. Therefore, there is a need for the teacher to develop interactive tasks that involve performing arithmetic operations of addition, subtraction, multiplication and division in the sections of "Ten", "Hundred", "Thousand" and "Multi-digit numbers". In this context, we have analysed online services that allow teachers to create interactive tasks that provide instant feedback and automatically evaluate the results of students' calculation activities: LearningApps, Liveworksheets, Wizer.me. Thus, two directions of ICT use in the formation of computing skills are proposed: the use of ready-made online simulators and the use of online services to create interactive tasks. As a result of studying the relevance of the problem of using ICT in the formation of computing skills in primary

school learners, a survey of primary school teachers was conducted, which showed the need of the teaching community regarding the aforementioned teaching aids.

INTRODUCTION

An essential feature of modernity is the rapid entry of information and communication technologies (ICT) in both professional and everyday life of a modern person. It is obvious that ICTs force the human brain to change and respond differently to information. Primary school learners are representatives of the digital generation, a generation that has been existing in both physical and virtual environment since childhood. According to the results of the international project EU Kids Online, in Europe 80–90% of children aged 3–6 use the Internet, and every second three-year-old uses a tablet or smartphone (Soldatova, Rasskazova, 2012), (Soldatova, 2018). In neighbouring countries, including Russia, a third of primary school children spend at least 8 hours online. A similar situation is observed in Ukraine (Skvortsova, Onopriienko, Britskan, 2019). As a result, today "digital children", characterised by certain features of the cognitive sphere caused by the influence of the virtual world, come to school. It should be noted that according to Kondratenko, the Ukrainian psychologist who studies the impact of ICT on the personality of modern school children (Honcharenko, Vavryk, Vereshchak, Kondratenko, 2014), the virtual world acts like physical, demanding the formation of the child's abilities that allow him/her to survive.

In today's world, it is almost impossible to avoid a child's contact with the virtual environment. Therefore, based on the desire of children of the digital generation to be in the virtual world, it is necessary to study the possibilities of using ICT in the educational process, in particular in the formation of computing skills. Thus, the educational process should be based on the possibilities of ICT, which provide teachers with powerful and modern teaching aids, in particular for the formation of computing skills in primary school learners, and thus have a positive impact on the effectiveness of this process. The negative effects of ICT can be corrected in the classroom through the dosed use of digital tools, as well as through the control and guidance of students' learning activities by the teacher.

Digital teaching aids provide educators with a large number of options for creating drilling exercises. As proved by psychologists (Menchinskaya, 1950) to form a certain skill or subskill, students need an average of about 20 drilling exercises. This thesis is confirmed by research data in neurophysiology which demonstrate that neural connections are formed within 7 days of their actualization. In order to develop the skills and abilities the teacher will find very useful all sorts of online services that offer students a large number of similar tasks with automatic verification. Performing such tasks, the learner for some time, resorts to training, and the possibility of automatic verification provides feedback, and the learner has information about the correctness of the exercises done.

The process of forming a good computing skill involves not only the discovery by students of the essence of the method of calculation, the calculation of schemes that present the approximate basis of action, but also the performing of a number of drilling exercises. Based on the needs of modern primary school learners in the presentation of educational information in the form of digital content, the question arises about the use of various interactive exercises and online simulators to form computing skills in them.

The purpose of the article is to analyse existing online simulators and services that allow teachers to create digital content for the formation of primary school learners' computing skills. Also, to present the received experimental data on the application of digital aids in the process of formation of 2nd grade pupils' computing skills.

1. ONLINE SIMULATORS FOR THE FORMATION OF PRIMARY SCHOOL LEARNERS' COMPUTING SKILLS

Scientists Brown, Rediger, and McDaniel link the process of acquiring knowledge and memory with physiological processes determined by the coordinated work of neurons and the formation of neural connections, and consider a characteristic feature of the brain – neuroplasticity, which is manifested in the ability to reorganize each new task (Brown, Rediger, McDaniel, 2019).

Thus, the formation of computing skills involves the strengthening of certain neural connections. The first such connections are formed when the child understands the explained material and works with it 1–2 times. A more lasting connection arises when, as a result of longer practice, the piece of material studied is applied in different contexts. Strong neural connections are formed because of interval repetition over a long period, and the development of a new skill takes an average of 21 to 28 days (Oakley, 2020; The power of habit, n.d.). It has been experimentally proven that the brain develops new skills and connections within 7 days of starting regular training. However, the acquired new skill disappears without support as quickly as it appears (What is "neuroplasticity", n.d.).

According to neurobiologist John Brewer, the formation of neural connections in the brain is associated with training (Brewer, 1999). One such training Brown, Rediger and McDaniel call online simulators, but point out the possibility of achieving good results through developing the habit of focused and persistent work (Brown, Rediger, McDaniel, 2019).

Some online simulators for the formation of computing skills in younger learners are posted on authors' sites, in particular on the site *OnlineMSchool* (https://onlinemschool.com/), which was created by Dovzhik (Ukraine). Among a number of simulators in mathematics on this site there are also calculation exercises for primary school. These include 13 tests: addition of two natural numbers, subtraction of two natural numbers, addition and subtraction of two natural numbers, multiplication tables, multiplication of one-digit and two-digit natural numbers, multiplication of one-digit and three-digit natural numbers, multiplication of two-digit natural numbers, multiplication of two-digit and three-digit numbers, multiplication of two three-digit numbers, multiplication of two natural numbers, division of two natural numbers, calcu-

lation with two natural numbers, division with remainder. When working online with computer simulators, the system records long sessions and thus directs the learner to speed up work. Moreover, this, as proved by Kawashima, a Japanese researcher and the author of the method of human brain development with simple calculations for time (Kavashima, 2012), actualizes the work of a large number of parts of the brain. Simulators for the formation of computing skills in junior high school students are offered by the educational online environment Mexico (http://miksike.net.ua), which is positioned as an educational online system that is a means of developing oral computing skills.

The educational project *Mexico in Ukraine* has been successfully implemented since 2014 in accordance with the Memorandum of Cooperation between the Ministry of Education and Science of Ukraine and OK MIKSIKE (Estonia). Within the project, teachers, learners, and parents are given the opportunity to create and use both their own online learning materials and an online collection of materials created by teachers – participants of the project.

In the context of educational reform in Ukraine, the project is designed to serve as a practical tool that helps to create an effective educational environment using modern information and pedagogical technologies. In order to develop computing skills in the system of *Mexico* they created the subsystem of *Pranglimine* (est. Pranglimine). This is a kind of platform that is recommended to be used by the Ministry of Education and Science of Ukraine for the development of oral mathematical calculations in learners of secondary schools (letter dated 17.08.2016 / 1 / 9–437 *"On Methodological Recommendations for Teaching Subjects in Secondary Schools"*).

Pranglimine is also considered as a powerful mathematical simulator for training and competitions in oral calculations for different age groups of users. The participants of this project are representatives of European countries – Latvia, Lithuania, Estonia, Slovenia and Ukraine, which participate in the annual competitions in oral calculations. In 2018/19, more than 70,000 participants took part in the first online stage of the competition in Ukraine. For primary school students, competitions are held in the following age groups: "chomuchky" ("why-so's") (grades 1–3) and "doslidnyky" ("researchers") (grades 4–6).

At the *Pranglimine* training ground, participants can choose feasible tasks (for adding, subtracting, multiplying and dividing natural numbers and integers) that involve filling in gaps or comparisons.

Pranglimine simulators are characterised by a clear structure and order. The tasks are divided into three categories: training with natural numbers, training with integers and training with decimal fractions. The second and third categories contain 7 types of exercises (addition, subtraction, addition / subtraction, multiplication, division, multiplication / division and random), and the first – 9 types (additional: comparison and insertion of the missing number).

Also, each type of tasks has levels of difficulty (from 1 to 6) and training is possible in two modes – standard and sprint. In the mode, the standard passage through each of the levels is 40 seconds. The transition to a higher level is subject to a certain number of points. In addition, the user can select a training on only one level for 240 seconds.

In sprint mode, the entire activity takes 190 seconds. The transition to the next level happens after completing all 5 tasks. If an error is made, the level drops by 1.

After selecting a task, a field appears in front of the participant, which displays the time and number of points. Participants have to perform as many exercises as possible with a minimum of errors.

If the user is registered on the site, their result is displayed in the table. The table of results provides a data filter by grade of learners, educational institution and territorial feature.

Computing simulators in the educational online environment of *Mexico* at the *Pranglimine* training ground, qualitatively differ from all online simulators in that: 1) a fairly large number of computational tasks are offered; 2) after completing the tasks, participants immediately receive on the screen a report on both the number of exercises performed and the mistakes made.

Systematic training for contestants has become possible thanks to the mobile application *MiksikeApp* on *Google Play*, which allows them to improve their oral computing skills using a mobile phone or tablet. The application works in off- and online modes and provides a small fee depending on the technical characteristics of the smartphone or tablet. To become acquainted with the application, there is a 10-day free version that can be downloaded at any time.

2. ONLINE SERVICES FOR CREATING INTERACTIVE CALCULATION EXERCISES

The benefits of using computing online simulators are beyond doubt and are confirmed by neuroscience data. At the same time, the question arises about the approximation of the content of tasks for the formation of students' skills of robust computing to the content of the tasks of a particular lesson. However, the training process is preceded by the process of developing computing skills. Therefore, there is a need for the teacher to develop interactive tasks, which involve the implementation of tasks from the textbook or activity book, which implements the stages of formation of mental actions, according to Galperin (Galperin, 1998). In this context, we have analysed online services that allow teachers to create interactive tasks that provide instant feedback and automatically evaluate the results of students' computing activities: *LearningApps, Live worksheets, Wizer.me.*

The possibilities of the *Learning Apps service* (http://learningapps.org/) as a means of teaching mathematics to primary school learners are analysed in detail by Skvortsova and Britskan (Skvortsova, Britskan, 2018), so we will not dwell on the general characteristics of this service but will note only that this service is one of the cloud services *Web 2.0* for the organization and support of educational processes and is a free international open educational resource.

A characteristic feature of *Learning Apps* is that there is a bank of ready-made interactive exercises available to the teacher, including computational ones.

Also, the teacher has the opportunity to either create similar tasks to those offered by the service or create their own interactive exercises using the tasks from a textbook or activity book.

It should be noted, in this online service, calculation tasks are checked automatically, and the results are displayed in the virtual class journal – correct / incorrect.

As not all *Learning Apps* templates are suitable for creating computational training exercises, we will consider those that we think are appropriate to use to create interactive exercises. For such interactive tasks the template *Fill in the blanks* is the most suitable. This template allows the learner to enter the results of numerical expressions, or to enter unknown components. The disadvantage of this template is the inability to present the task in the form of an image of the task from the textbook or activity book; there is only the possibility of presenting the task in the form of text.

Teachers can also design calculation problems in the *Free Text Answer* template, but students should write the results of the numerical expressions below the expression. But this template allows you to download both text and images. If the task is loaded in the form of a drawing, it will look the same as in the textbook or activity book. The service instantly checks the completed tasks and allows the learner to receive the test results – the tasks in the green frame are performed correctly, and in the red – incorrectly.

Teachers can also download a task as a picture in the *Image Fragments* template. This template is convenient to use for computational tasks in the form of chains or tables. In this case, the learner does not enter the answer, but chooses the answer from the suggested ones. Thus, clicking on the pin opens the student's answer options, one of which he/she clicks the mouse on.

We see the expediency in creating interactive exercises for calculations in the template *Find a pair*. Here it is possible to present the task both in the form of a text and in the form of a drawing. When completing the task, students have to choose a numerical value for the expression and move it to the expression so that they are grouped. The advantage of *LearningApps* is that learners can be given a link to a task both as a link and as a QR code, and it can be downloaded to any gadget that is connected to the Internet.

Liveworksheets (https://www.liveworksheets.com/) is a designer of interactive worksheets that look like a regular activity book. The service allows the teacher to use ready-made tasks created by other teachers, and he/she can see in which template each interactive task is performed.

To create interactive worksheets, the teacher can download the pages of an activity book and, using keywords that match different templates, make each task of the book interactive. Moreover, learners can repeatedly perform tasks in order to obtain a perfect result. After the learner completes the task, the service instantly checks the correctness of the obtained solutions. Correctly performed tasks are marked in green and incorrectly performed or missed tasks in red.

Worksheet tasks are created in the template *Text field for writing the answer*, which involves writing numbers directly in the cells of the activity book. This template is the most attractive for creating interactive computing exercises.

It should be noted that the *Text box for writing an answer* template is similar to the *Fill in the blanks* or *Free text answer* templates of *Learning Apps*, but the ability to make a printed book page interactive thanks to *Liveworksheets* seems more attractive.

In addition, the *Liveworksheets* service has the ability to enter, namely in the solution schemes, the required numbers, which allows you to visualize the calculation process, to clearly present the approximate basis of computing activities.

In the tasks created in the *Movement* template, learners have to drag another equality to equality, which is a test of the correctness of the solution. This template is analogous to the *Learning Apps* template, but in this *Movement* template the task condition is overlapped by its answer, which is inconvenient. For training exercises for the formation of computing skills, the use of this template is quite limited due to the small number of this type of exercises.

An analogue of the *Learning Apps* template in *Liveworksheets* is the *Line Drawing* template. This template can be used in problems to calculate the values of expressions by selecting the answer from the proposed number. However, the number of expressions and the number of answers must match; extra numbers cannot be added, so in this template it is possible for the learner to guess the answer. Therefore, we will not use it as training exercises for the formation of computing skills.

The *Wizer.me* service (https://app.wizer.me/), similarly to *Liveworksheets,* is an interactive worksheet designer, on which teachers can create their own simulators for the formation of computing skills. The service allows the teacher to view and use ready-made interactive worksheets, but when viewing it is not possible, as in *Liveworksheets*, to find out in which template the task is completed. Let us limit ourselves only to the templates of this service, which allow teachers to create simulators for the formation of computing skills.

The *Fill in the image* template is analogous to the *Text box for writing a response* template in the *Liveworksheets* service – the task is downloaded as a picture from an activity book, but unlike *Liveworksheets* there is no text box for writing a response, it should be opened in *Wizer.me*. You can also consider similar templates *Free text response* and *Fill in the blanks* from the *Learning Apps* service. But the *Learning Apps* template does not allow you to download the task in the form of images.

Wizer.me also has a *Match Pair* template, which is similar to the *Line Drawings* template in *Liveworksheets* or the *Learning Apps Pairing Pattern*. But, as we mentioned above, we consider it inexpedient to use, because the number of numerical expressions and numerical results is the same, and at some stage learners can guess the answers.

3. FORMATION OF COMPUTING SKILLS OF ADDITION AND SUBTRACTION OF TWO-DIGIT NUMBERS USING ONLINE SIMULATORS AND INTERACTIVE EXERCISES

Experimental work on the formation of computing skills of addition and subtraction with the transition through the category continued in the I–II semester of 2019/2020 academic year in the 2nd grade of Ivano-Frankivsk secondary school № 11. In the I semester in 2-A, 2-B and 2-C classes there were conducted entrance testing sessions, the purpose of which was to determine two grades approximately equal in average indicators of the formation of computing skills of addition and subtraction with the transition through the category within 20. To select two classes for participating in the experiment we used the following research methods: the study of school documentation

– class journals, interviews with class teachers, testing of the students of two classes selected on the basis of analysis of documentation and content of conversations. The diagnostic test was designed according to the method of Agibalov (Agibalov, 1987). It contains 30% of reproductive tasks; 50% of partially productive; 20% of productive-creative tasks. A properly performed task of reproductive nature is estimated at 1 point, of partially productive – at 2 points, and of productive – at 3 points. When processing the results, the coefficient of test performance (K) was calculated – the ratio of the total number of points obtained by learners during the test to the maximum number of points per test, i.e. the total number of points in the correct performance of all test tasks.

Entrance testing was conducted in the form of independent work. Here is the content of test tasks:

Part I:

| Variant 1 | Variant 2 |

1. Calculate the values of the problems by performing an expanded record of the solution:

| 13 – 6 7 + 4 15 – 8 | 4 + 8 12 – 5 17 – 9 |

Part II:
2. Calculate the values of the problems in different ways:

| 14 – 7 5 + 8 11 – 5 6 + 5 15 – 9 | 15 – 7 6 + 9 11 – 5 5 + 8 13 – 7 |

Part IІI:
3. Arrange parentheses and signs of arithmetic operations so as to obtain true equality:

| 7…4…5…6 = 12; 3…7…6…7 = 9 | 7…6…4…9 = 8; 4…9…6…3=10 |

Table 1 shows the test results during the ascertaining experiment:

T a b l e 1

The average coefficient of test performance by classes

Classes	Average number of points for Part I	Average number of points for Part II	Average number of points for Part III	Average number of points for the test	Maximum number of points for the test	Coefficient of test performance
2 – „A"	2,8	5,9	2,4	11,1	19	0,58
2 – „B"	2,82	5,95	2,5	11,3	19	0,59
2 – „C"	3	6,7	3,4	13,1	19	0,69

It should be noted that the table shows the ratio of the number of learners who have computing skills of addition and subtraction within 20 with the transition through the category to the total number of students in the class.

As you can see from Table 1, classes 2-B and 2-A are approximately the same in terms of averages, so they were selected as experimental and control classes: 2-A was selected as experimental and 2-B – control class.

The purpose of the formative experiment was to test the effectiveness of the use of digital tools in the formation of computing skills of addition and subtraction with the transition through the category in primary school learners.

In December 2019 – February 2020 and early March 2020 in the experimental and control classes there was a traditional training, during which learners mastered the techniques of calculation within 100 with the transition through the category: addition and subtraction in parts, bitwise addition and subtraction, addition based on rules for adding a number to the sum, subtraction based on the rule of subtracting a number from the sum, as well as rounding. During the traditional training in the school, students performed tasks using the material of teaching – a textbook and an activity book. Beginning on March 12, during the quarantine caused by the COVID-19 pandemic, computing skills were developed in the experimental class using interactive exercises created in the online service *LearningApps*, *Liveworksheets* and using online *Pranglimine*. Training in the control class took place without the use of interactive exercises *LearningApps, Liveworksheets* and online simulators.

Based on the characteristics of learners – representatives of the digital generation, namely the clip of their thinking, taking into account the neurophysiological principles of human brain development by means of calculations (Kawashima, 2012) and interactive approach to learning (Oakley, 2020), in order to develop computing skills, we created a complex of interactive exercises in the online service of *LearningApps*. Thus, the system of interactive exercises contained tasks for calculations, presented in the traditional form, tasks presented in the coded form, in which the sign of the arithmetic operation of addition was marked by a triangle, and subtraction – by a circle (Fig. 1). The tasks were created in the *Fill in the blanks* template, which allows students to enter the results of calculations immediately after the equals sign.
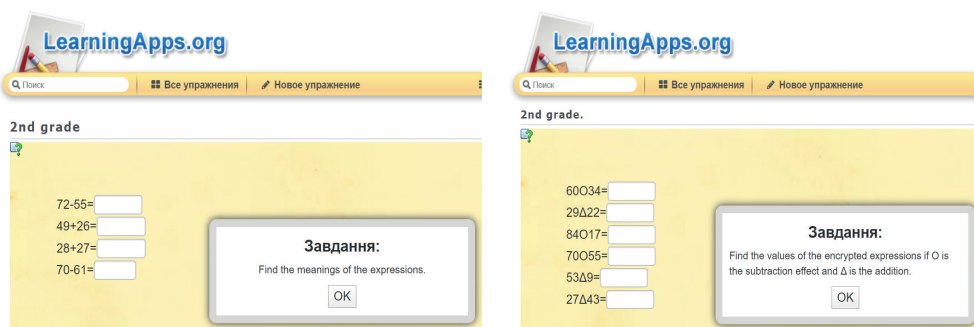

F i g u r e 1. Interactive calculation exercises created in the *Fill in the blanks* template in the *LearningApps* service

S o u r c e: own work.

This is the most convenient template for creating interactive computing exercises. But this template does not allow you to download the condition of the task in the form of a picture – a screen from a textbook or an activity book. Therefore, to create interactive exercises based on the picture – the task screen from the textbook, it is advisable to use the template *Fragments of images*. In this template it is advisable to create interactive exercises for calculating the unknown components of the arithmetic operations of addition and subtraction (Fig. 2).
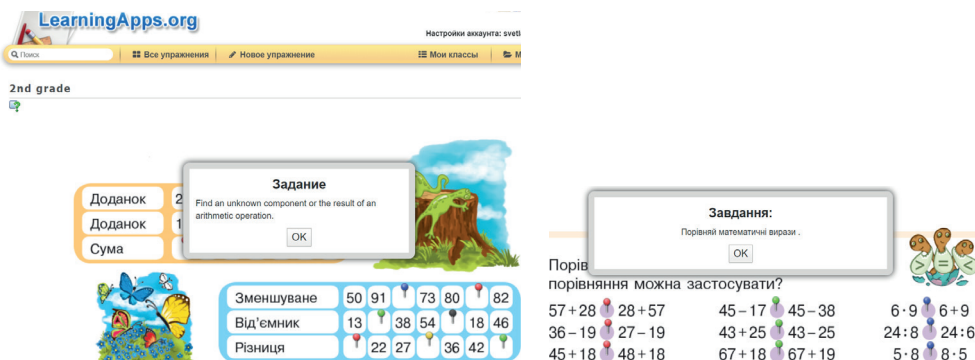

F i g u r e 2. Interactive calculation exercises created in the *Fragments of images* template in the *LearningApps* service

S o u r c e: own work.

In order to develop good computing skills, learners need to be offered a large number of training exercises over a long period of time. Therefore, we have prepared more than 20 interactive exercises in the templates of the *LearningApps* service. At the same time, taking into account such a feature of clip thinking of students of the digital generation as fast switching, students should be offered interactive exercises created in different services. Thus, learners will perform interactive exercises, which are presented in different forms, in significantly different patterns. Therefore, in addition to the *LearningApps* service, we also used the *Liveworksheets* services.

The Answer Text Box template in *Liveworksheets*, as well as the *LearningApps*' *Fill in the Blanks* template, allow teachers to create interactive computational tasks. Students should also write down the numbers that are the results of the calculations in the appropriate places, which are marked with boxes for writing answers. Unlike *LearningApps, Liveworksheets* has the ability to download a picture – a screen of the textbook task, which is much more attractive to learners (Fig. 3). Downloading the task condition in the form of a drawing makes it possible to direct the learner to use a certain method of calculation, focuses their attention on the individual steps of the indicative basis of action.

In addition to the interactive exercises created in the *LearningApps* and *Liveworksheets* services, the online classroom *OnlineMSchool, Mexico (Pranglimine)* was used in the experimental class. The tasks used with these simulators concerned the use of computing techniques within 20 of different complexity. The principle of interval learning was applied, when the performance of a certain type of task was repeated

under the condition of a certain interval, which was at least one day (in each mathematics lesson).

F i g u r e 3. Interactive calculation exercises created in the *Text box for writing the answer* template in the *Liveworksheets* service

S o u r c e: own work.

In order to determine the effectiveness of the use of interactive exercises and online simulators in the process of developing computing skills, after the completion of experimental training, the testing of learners of experimental and control classes was conducted.

The testing was conducted in the form of independent work. The final test was also designed according to the method of Agibalov (Agibalov, 1987). Here is the content of test tasks:

Part I:

Variant 1	Variant 2

1. Calculate the values of the problems by performing an expanded record of the solution:

53 – 36 47 + 24 75 – 42	34 + 28 62 – 45 87 – 34

Part II:
2. Calculate the values of the problems in different ways:

24 – 17 25 + 28 14 – 7 6 + 9 65 – 24	45 – 37 64 + 28 11 – 5 5 + 8 85 – 33

Part III:
3. Arrange parentheses and signs of arithmetic operations so as to obtain true equality:

37…24…45…16 = 0; 53…17…26…17 = 79	74…16…37…17 = 0; 41…29…16…32 = 86

Table 2 shows the results of the final testing.

We should note that the table shows the ratio of the number of learners with certain skills to the total number of students in the class.

Table 2 shows that the average formation of computing skills of addition and subtraction in the experimental class is much higher than in the control class. This gives grounds to draw a conclusion about the effectiveness of the use of interactive exercises and online simulators in the process of forming elementary school learners' computing skills compared to traditional methods.

The average coefficient of test performance by classes

Classes	Average number of points for Part I	Average number of points for Part II	Average number of points for Part III	Average number of points for the test	Maximum number of points for the test	Coefficient of test performance
Exper.	3	8,2	3,7	14,9	19	0,78
Contr.	2,45	5,88	2,43	10,76	19	0,59

CONCLUSIONS

Changes in modern society necessitate the use of digital tools. That is why learners of the digital generation, who started using the Internet at a preschool age, come to primary school today. Entering the virtual world causes changes in their cognitive development. Children are more actively developing those abilities that allow them to survive in the modern world.

The mechanisms launched by world progress no longer allow the child to use the virtual environment. Therefore, it is advisable to use ICT for educational purposes, in particular for the formation of computing skills, which significantly affects the effectiveness of this process, and the negative effects can be eliminated by adjusting the necessary dosage of the time of their use in the classroom.

Most primary school learners are characterised by clip thinking, which is dominated by visual perception of information through its presentation in the form of diagrams, pictures, or video images. This can be used in the construction of the educational process, when the use of digital tools, in particular online simulators, allows learners to quickly and efficiently master the training material, to develop their computing skills. We analysed online services that allow teachers to use ready-made tasks *(OnlineM-School, Mexico (Pranglimine))* and create interactive exercises to identify feedback and evaluate the results of computing activities of students *(LearningApps, Liveworksheets, Wizer.me).*

The effectiveness of the use of online services for the formation of computing skills in primary school learners was evidenced by the results of the experiment. Thus, the diagnostic test was built according to the method of Agibalov (Agibalov, 1987), in which the design of tests takes into account four levels of learning by students. Those levels of knowledge acquisition were determined using test tasks of three types: 30% were reproductive tasks; 50% – partially productive; 20% – productive, i.e. creative tasks. A properly performed task of reproductive nature is estimated at 1 point, of partially productive – at 2 points, and of productive – at 3 points. The average values of the final test were determined by the experimental and control classes.

The results of the formative experiment showed the effectiveness of using interactive exercises and online simulators *(LearningApps, Liveworksheets and Pranglimine)* in the process of developing computing skills in primary school learners compared to traditional methods.

Prospects for further research are to create interactive tasks in other services, including *Wizer.me*, in order to form the computing skills of primary school learners in the concentration of "Ten", "Hundred", "Thousand", and "Multi-digit numbers".

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