How to Start Teaching Programming at Primary School

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Abstract. This article describes the authors' approach to start teaching programming at the primary school, which is based on using distance learning site DL.GSU.BY for sequential leaning seven keywords (program, var, longint, begin, readln, writeln, end) of programming language Pascal. Then these words are using to write the simplest programs that read some numbers, do necessary calculations and write the answer.

Keywords: primary school, programming teaching, distance learning tools.

1. Introduction

Many years the authors prepare scholars of Gomel region for Olympiads in Informatics. All work is doing on the base of distance learning system DL.GSU.BY, created at the Faculty of Mathematics and Technologies of Programming of F. Scorina Gomel State University. Since 2007, training begins with the first grade of primary school. The first stage of training – development of thinking of preschool children and children of primary school age is described in (Dolinsky, 2014). This article presents the authors' approach to learning the first keywords used for Pascal programs: "program, var, longint, begin, readln, writeln, end" and their translation into Russian, as well as their order in the first program. Fig. 1 shows our training goal.

One can see that the exercise was elaborated in the year 2007. Long-term experience of teaching children in programming using this method allowed us to better understand the problems of studying the subject, to improve and develop the learning system.

Chapter 2 presents technology of training. Chapter 3 describes materials for work at the table. Chapter 4 contains remarks on personal learning and teaching in the described process. Finally, chapter 5 contains conclusions.

Fig. 1. Goal of teaching.

2. Technology of Training

Thus, a complete list of children's problems when learning the key words for writing the first Pascal program looks like this:

- To remember the order of the keywords.
- To remember correct spelling of the keywords.
- Learn how to type words on the keyboard.
- To remember translations of the keywords into Russian.

To simplify the memorization of the order of commands, we began to study them using a color background corresponding to the arrangement of colors in the rainbow: red, orange, yellow, green, light blue, blue, purple.

To simplify the memorization of the meaning of the keyword, we select the corresponding image, the meaning of which is explained to the child, if necessary (Fig. 2).

All exercises follow in the order of appearance of the new keyword. I.e. at the beginning there are exercises for "program", then for "var", then for "program – var", then for "longint", then for "program – var – longint" and so on. Special group of the exercise helps memorize letters and their order in keywords. In the process of training, an "unexpected obstacle" appeared – it is customary to type the keywords with lowercase letters but the uppercase letters are written on the keyboard and for many letters their lowercase and uppercase letters are not alike.

Fig. 3 shows an exercise aimed at solving such problems:

To do the exercise one needs to click onto letter for moving, as a result it becomes of red color. Then one needs to click on the button "<<<" to move the letter left or click on the button ">>>" to move the letter right.
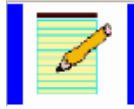
	Program	Bear cub sits at the computer and type a program
	Var	The magician takes out different objects from the tall hat, and they change all the time, a bunny, ribbons …
	longint	The painted lilt digit "one" is well associated with the word number
	Begin	Alarm clock rings at the beginning of the day
	readln	The book is opened to read it
	writeln	Pencil writes on paper
	End	The stop sign means the end of the program

Fig. 2. Meaning of the pictures.

Поставьте буквы по образцу:
PROGRAM
RGPOMRA
<<<   >>>

Поставьте буквы по образцу:
program
rgpomra
<<<   >>>

Поставьте буквы по образцу:
program
RGPOMRA
<<<   >>>

Fig. 3. Exercises for permuting letters.

One can see that at the left exercise you need to reorder uppercase letters with uppercase example, at the exercise in the center you need to reorder lowercase letter with lowercase example, and at the right exercise you need to reorder uppercase letters with lowercase example. In the first and second exercises a child may simply use example immediately, but to do the third exercise he needs to remember correspondence of the uppercase and lowercase letters.

Practice showed that for many children it is not enough to do the exercises presented above so we add a set of different auxiliary exercises shown below.

Fig. 4 presents exercise where one also needs to form the keyword "program" by letters permutation, but there is some help: a keyboard is shown on which the letters on the keyboard, which you need to type at the moment, are marked with a yellow color. If the letters are typed correctly, they are green. If the child makes a mistake, the color of the letters becomes red. The letters at input are typed as lowercase letters, showing which lowercase letter correspond pointed uppercase letter.

Fig. 5 presents exercise for memorizing the letters and their order in the keyword PROGRAM. The exercise starts from one letter, then come the second, the third, etc. Fig.5 shows exercise (the eighth exercise in the packet), where one needs to put the first four letters of the keyword PROGRAM in right order. The first letter is given, so the cell for the second letter appears. Note that the wrong letters do not move, so the child must find the right letter and move it to the right place. When the last fourth letter is put in place, the exercise appears with the first 5 letters of the keyword PROGRAM, etc.

The next problem that must be solved to type keywords (after remembering letters and their order) is to remember where the letters are at the keyboard. To solve that problem we create the following exercises, represented at Fig.6 and Fig. 7.

In the exercise in Fig. 6 (left side) one needs to move each letter of the keyword onto its position at the keyboard. Note that if a letter is moved onto its position, the letter jumps there.

In the exercise in Fig. 6 (right side) one needs to move each letter of the keyword from its position at the keyboard onto a cell of the keyword. If a child made an error the letter jumps to its source position on the keyboard.

Additional tips that one can get by clicking onto button "Don't know" is represented in Fig. 7.
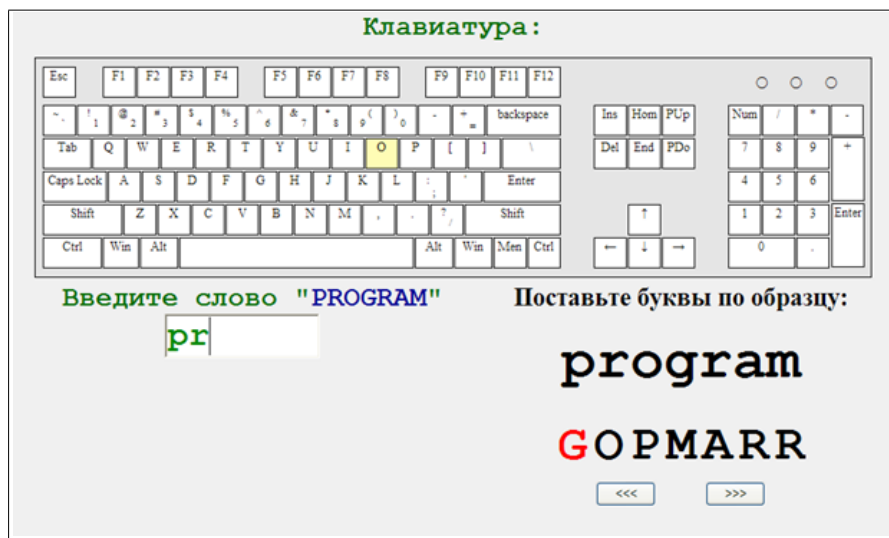

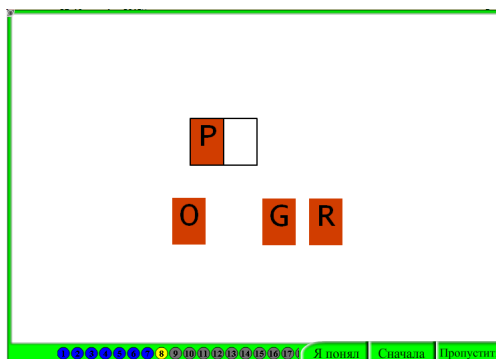Fig. 4. Type and permute letters of the keyword PROGRAM.

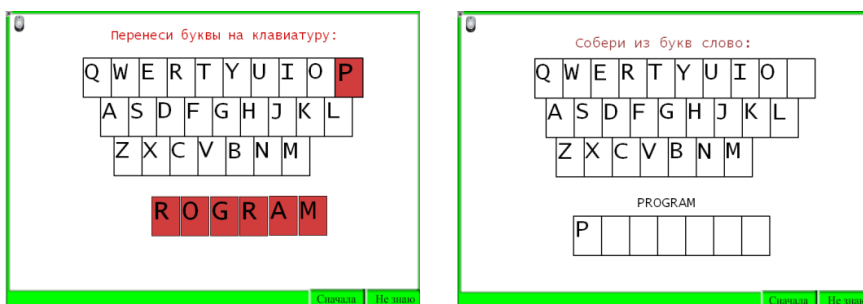Fig. 5. Compose the word PROGRAM letter by letter.

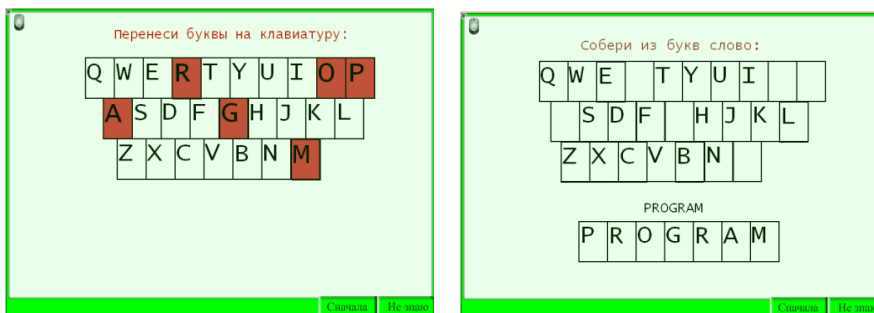Fig. 6. Remember letters layout at the keyboard.

Fig. 7. Tips for exercises from Fig. 6.

After the child remembers letters and their order in the keyword, correspondence of lowercase and uppercase letters of the keyword and the letters layout on the keyboard, we can train the keyword typing. To carry out this work the following exercises are offered:

Fig.8 represents exercise for typing keyword with tip. The letter to be typed is indicated in yellow in the picture of the keyboard, the correct printed letters are green, but the wrong printed letter is red.

Fig. 9 represents exercise for typing of absent letters of the keyword. At first the letters are typed in order (first letter, second letter, etc), and then absent letters are in random order.

Fig. 10 shows the exercises that check whether the child remembers the image, the English keyword, the Russian translation, and their mutual correspondence.
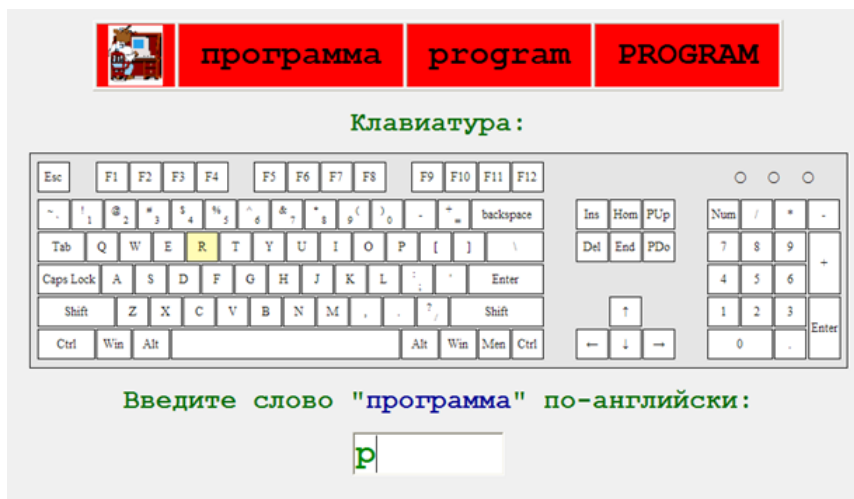
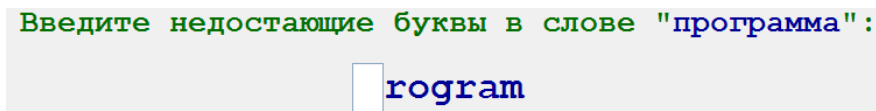Fig. 8. Typing of the keyword PROGRAM with tip.
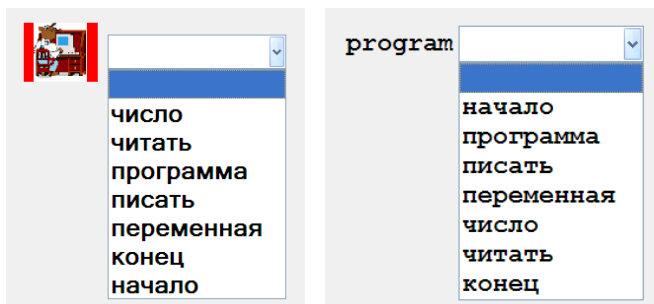
Fig. 9. Typing of absent letters.

Fig. 10. Correspondence of the Russian word to the image and the English word.

3. Materials for Work at the Table

When we started work in the autumn of 2007, special attention was paid to working at the table. At first we tried to reduce the time for working with computers, so that they would be enough for each child. Secondly, we did not have computer analogues of these exercises.

First of all, this is the workbook "Learn keywords", presented in Fig. 11. It contains all the keywords you need to remember: pictures, keywords, translations, and a set of exercises for learning and memorizing. For example, join letters of a keyword, point the position of the letter on the keyboard, etc. In addition, such notebooks help to develop skills of correct writing letters (pen on paper) and keywords. The notebook is provided to the child on demand, first of all, for independent work at home. To work in the lessons, as a rule, the materials shown in Fig. 12–17 are used.

Fig. 12, for example, represents some sets of cards that are used for the words to be remembered.

Some exercises:

A) Gather the cards in order shown on the Fig. 12.
B) Contest "Who will quickly collect a table with keywords from the cards".
C) Find absent card or cards.

Fig. 13 contains keywords table that allows adding the following exercises:

D) Gather the cards with example.
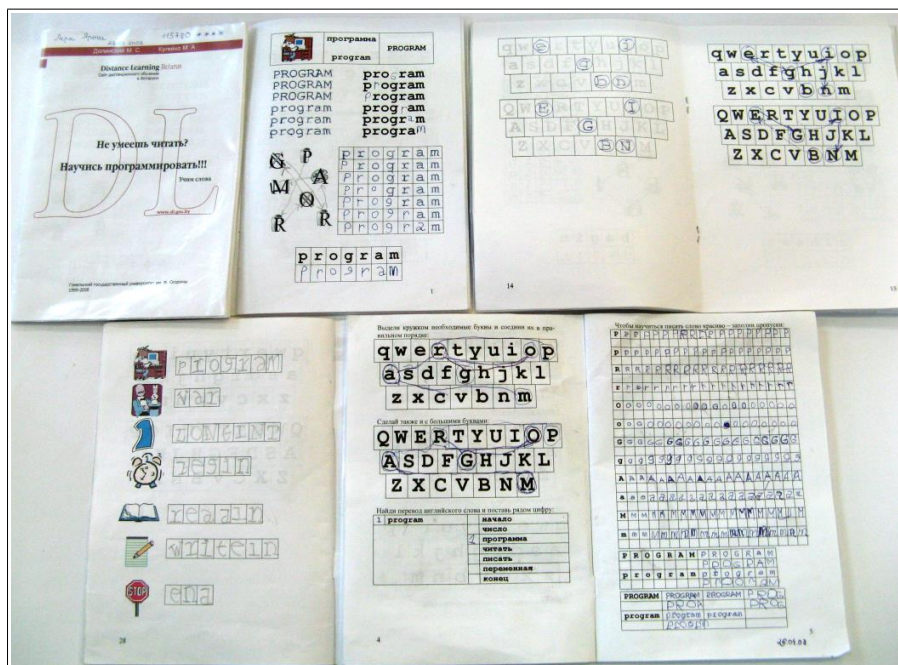E) Gather the cards onto keywords table.

Fig. 11. Notebooks for work at the table.

Fig. 12. Color cards with keywords.

Fig. 13. Color keyword cards with keywords table.

Fig. 14 shows the table of keywords in black and white colors, which makes it difficult to apply the above exercises because of the disappearance of "color support".

Great attention is given to work with letters of English keywords. Fig. 15 contains cards which allow compiling the keywords from lower- and uppercase letters, with or without samples, for a separate keyword or for all keywords.


Fig. 14. Black and white cards and sample.
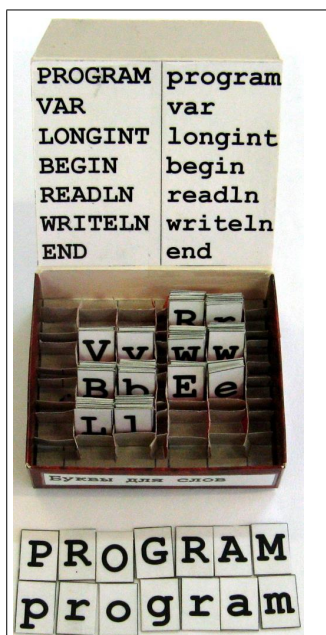
Fig. 15. Box with the keywords letters.

Fig. 16. "Paper" keyboard with letters of PROGRAM.

Fig. 17. "Box" keyboard with keyword PROGRAM.

Fig. 16 represents "paper" keyboard. Children can put letters of given keywords onto it.

Fig. 17 shows the "prototype keyboard", which is made from glued matchboxes containing letters on the positions of the real keyboard. In this way, we can train memorizing the keyboard layout without a computer.

4. Personal Learning and Teaching

As a result, we created a training system where each child receives exercises that are feasible for him in complexity and at the same time leading (albeit at different speeds) to a common goal – to teach typing key words on the keyboard of the computer in the Pascal programming language: "program, var, longint, begin, readln, writeln, end", and also remember their order in the program and their translation into Russian. All this together is the best basis for a simple transition to the creation of the first program "reading and writing number".

Individual training and teaching provide a rich set of exercises at the table, as well as computer-based automatic personal exercises, appointed depending on the results of previous exercises. In addition big set of exercise packets supporting different entry points to learning, including: "Propaedeutics of keywords", "Learn keywords", "Auxiliary learning": "program", "longint", "begin", "readln", "writeln". The standard approach is to start with "Keyword Propaedeutics", then go to "Learn keywords". If the child has forgotten a keyword, he can repeat it in "Auxiliary Learning" for this keyword.

5. Conclusion

This article presents an authors' approach to starting teaching programming in elementary school, based on the consistent use of seven key words in the Pascal programming language necessary to create simple programs that read some numbers make the necessary calculations and write the answer.

It is important to note that we have many exercises with different levels of difficulty to work both on the computer and at the table. They provide effective individual education and training for children with different levels of training and motivation. The presented system of teaching and learning is scalable and can be used even by teachers and parents who are initially far from programming, as shown by the present practice. Initially, you can conduct joint training. And after that, when the child "gained speed" successfully continue the classes on their own.

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Performance Statistics of Gomel pupils at international and national olympiads in informatics since 1997 up to 2017. (In Russian): `http://dl.gsu.by/olymp/result.asp`

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