

Logo for the Would-be Teachers of the Computer Science Elementary Course

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Abstract

A course "Logo Programming Language" has been given to the Primary School Department of the Karelian State Pedagogical University for many years. Its content is developed in other courses – "Information and communication technologies in primary education" and "Teaching methods of computer science education". The target audience of the course are would-be primary school teachers, majoring in "Mathematics and Computer Science". While creating the course, there were 2 main problems to solve: selecting the content and reasoning the teaching methods, appropriate for the demands of the specialty. The course curriculum comprises not only the Logo Programming Language structure and programming technology but contents and teaching methods of the Logo Programming algorithmization basics to the Primary School students as well. The opportunities of Logo (Micro Worlds version) in creating education environment, which enables organizing collaborative student creative work in Primary School and ways of Logo integration into subject area are also being analysed. The real results of the course are student-researched training software for the Primary School subjects.

Keywords

Computer science, would-be teachers, students, teaching methods, specialist courses, Logo, training programming language, primary school, Micro Worlds.

1. Introduction

Transition to earlier Computer Science studying at schools of Russia, more intensive use of information and communication technologies (ICT) in studying processes pose new problems for the elementary school education. In this reference, the training of Elementary school teachers ready to ground Computer Science and use information and communication technologies in school students training has become urgent. New courses and specializations are being introduced in some pedagogical colleges and teacher-training universities. Elementary School Department of Karelian State Pedagogical University in the middle of the 1990s introduced a new course dealing with teacher-training of grounding computer science and information and communication technologies (ICT) in grades 1 to 6.

Much attention in would-be teachers training during this course is paid to the Logo language studying. There are a few prerequisites for that:

1. Scrutiny of the content field "Algorithms and targets" in Elementary school supposes the use of one target or target family.
2. Appropriacy of the Logo language to the requirements of the training programming language

3. Possibilities of Logo-environment to study not only basics of algorithmization but other content areas of the computer science and ICT, as well as upbringing information competency with schoolchildren.

4. Growing interest to the Logo language in Russia and in the Republic of Karelia, in particular.

Let us comment on these points. Compulsory level of computer science curriculum in Russian schools has a few content fields: information and information process, modelling and formalization, algorithms and targets, computer, information technologies, computer communications. Students' knowledge and skills can be developed with the purposeful use of Logo language. While analysing the computer science curriculum, we uncovered means that can be used for / in studying each content field with the use of the MicroWorlds environment.

Table 1. Tools of MicroWorlds Environment

1. content lines	Tools of the Logo language and MicroWorlds programme environment
2. algorithms and executors	<ul style="list-style-type: none"> • system of instructions/ commands and sensors of the Logo language • control of the Turtle • control of a few objects
3. information	<ul style="list-style-type: none"> • examination of all types of information • coding information
4. modelling and formalization	<ul style="list-style-type: none"> • construction of graphic models (static and dynamic) • construction of information models of the objects (the Turtle, a button, colour, text box, slider) • construction of an information model of a task
5. information technologies	<p>Use of applications of MicroWorlds</p> <ul style="list-style-type: none"> • Text editor • graphic editor • music editor

Many Russian schools incorporate Logo in computer science curricula, stipulating its studying as the first programming language, or as optional classes. Several textbooks (Vitukhnovskaya A., 1998, 2003, Dobudko T., 1997, Djakonov V., 1991, Tuur S., 2002) and parts in computer science school textbooks (Computer Science (Ed) Makarova N., 1998, 2000) are devoted to the Logo environment. The Russian Institute for New Technologies (INT) plays an important part in the popularisation of Logo. The Institute translates Logo-interpretations into Russian, creates and distributes Logo-based programmes and does a lot of teaching and methodological work (MicroWorlds, 1994, LogoWriter, 1991, 1995). In a number of schools in Karelia, Logo is being taught from the 5th or 6th grade, sometimes in an elementary school (it seems that the tendency is prone to develop).

Taking into consideration all mentioned above, while educating would-be computer science teachers at the Elementary school teacher-training Department we consider Logo language as:
an educative programming language

a professional language for writing educational software tools for the elementary school

an environment for object-oriented teaching

a means of creating mathematical concepts

from the point of view of methods of its teaching in 3rd-6th grades.

Therefore, Logo language is being studied by the students in three disciplines:

1. Basics of programming in Logo language
2. Information and communication technologies in Elementary education
3. Teaching methods of computer science.

2. About the course “Basics of Programming in Logo Language”

Within this course we are viewing Logo as a training programming language, for it has the following characteristics:

1. Realises all algorithmic structures
2. Provides single-step execution of the programme and visualization on every step
3. A student does not need large propaedeutical background for writing first programmes
4. There is a Russian version of interpreter

In the first stage of the course development, we acquainted students with the release of Logo for Yamaha computer configuration and with the language Logo Writer; afterwards – with the programme environment Logo Worlds: firstly for the Macintosh configuration and at present for the IBM PC. The author has published two training aids for university and school students (Vitukhnovskaya A., 1998) and (Vitukhnovskaya A., 2003).

As it is now, the specialist course “Basics of programming in Logo language” is planned for 72 hours. The aims of the course are:

1. Studying the Logo programming language structure
2. Developing skills for writing programmes in Logo language
3. Learning methods of creating projects in MicroWorlds programming environment. These purposes mean that graduates of Elementary school teacher-training Department, having passed the special course mentioned above, are to be able to teach Logo to children. Alongside, Logo would be desirably useful for the students, who are going to teach computer science and information technologies without Logo. Therefore, the fourth purpose or the course is defined as:
4. Setting up skills and knowledge in other (except programming) computer science content lines

When planning the course “Basics of Programming in Logo Language”, it was necessary to solve the following questions:

- to define criteria for selecting topical content

- to select topical content
- to define structure of the course (logic of expounding the course)
- to ground the methods of teaching, appropriate for the needs of each specialization.

3. Selecting topical content

While selecting the topical content for the course we relied, on the one hand, *on methods of programming languages study*, customized in the teaching methods of computer study. On the other hand, we aimed at the course's purposes and peculiarities of the target audience – a group of students of Elementary School Department of Karelian State Pedagogical University, entitled to teach computer science and ICT in grades 1 to 6 after graduation.

The Author of one of the textbooks in computer science teaching methods, A.Bochkin(1998), defines the following levels of learning a programming language:

- mastering the part of the language, common for the programming language of this type.
- mastering tools of this particular language in general, its “gist”
- studying peculiarities of the specific language on the specific computer modification.

The choice of the course parts is determined by the following circumstances:

- the requirements of teaching any programming languages (firstly, the necessity of learning all algorithmic structures),
- the peculiarities of the Logo language, traditions in its learning,
- the peculiarities or the specific MicroWorlds environment

Sequence of the course's parts mostly reflects psychologically accepted stages of acquiring knowledge: from image information operation to verbal information operation. Besides, the premium place of Turtle graphics in the course reflects the traditional approach to Logo studying. At the same time, Turtle graphics is quite an independent part of the course, preparing learners for mastering all algorithmic structures of the language, technologies of procedure generation (including parameters procedures) as well as recursion.

Parts, aimed at words and lists learning, facilities for text processing and dialog organizing have an important place in the course “Basics of Programming in Logo Language”.

4. Thematic plan of the course

Consequently, the course “Basics of Programming in Logo Language” includes the following parts:

Table 2. Thematic plan of the course

1. Logo language characteristics (place in classification of programming languages)	2
2. Logo language structure (alphabet, vocabulary, syntax, semantics)	2
3. Basic concepts of Logo language	2
4. Turtle graphics	10

5. Procedure	4
6. Cycle algorithm	6
7. Branching	4
8. Variables	8
9. Arithmetic and logic operations	4
10. Processing of text information. Dialog organization	8
11. Operations of words and lists processing	8
12. Objects of MicroWorlds environment	4
13. Dynamic graphics	4
14. Technology of making a project	6
Total	72

5. Brief description of the course's themes

1. Logo language characteristics (place in classification of programming languages)

Above all, we had to define the place of Logo in classification of programming languages. This matter deserves consideration from different points of view. Most specialists place Logo to specialist languages, for it has been created for teaching school students programming. (Mogilyov A., 2000). From the point of view of G.A. Zvenigorodsky "Logo in the best way meets requirements of training intercultural language" (Boronenko T., Ryzhova N.(1999). Some specialists ground Logo's reference to languages of functional programming.

In terms of semantics of computational process Logo is placed to languages of procedure programming, fulfilling principles of moduling and structured programming. A programme in the Logo language is an aggregate of procedures. This, for its turn, makes Logo an open (extensible) language, its vocabulary is increased with procedures – new commands and sensors, which then can be used in the very same way as elementary commands and sensors (primitives).

2. Logo language structure

Alphabet of the language. Vocabulary of the language (commands and functions, primitives and procedures). Syntax of the language. Types of syntactic constructs. Semantics of the language. Types of primitives based on the function, origin, content.

3. Basic concepts of Logo language

The Logo language provides opportunities for working with different kinds of information: (image, text, audio), with a few types of data (numbers, words and lists), with various objects (depending on the specific edition).

4. Turtle graphics

Primitives of Turtle graphics. Ways of generating and activating Turtle graphics. Commands of positioning (absolute parameter changing – coordinates and an angle). Pair commands and functions.

5. Procedure. Variables

Procedure. Procedure name. Procedure format. Embedded procedures (sub procedures). Ways of procedure use (from the command field and in another procedure amount, of a higher level hierarchy). Local variables. Global variables.

6. Cycle algorithm

Concept of the cycle. Cycles on condition. Cycle with preset number of repetitions. Recursion.

7. Branching

Concept of Branching. Complete and incomplete branching.

8. Arithmetic and logic operations

9. Processing of text information

Concept of a text. Ways of creating and editing a text. Text output in the command field, text box, alarm board. Text editor. Text creating, editing, formatting primitives.

10. Dialog organization

Concept of a dialog. Ways of dialog organization. Procedure as a means of dialog organization. Command *ask* – function *answer*. Keys programming.

11. Operations of words and lists processing

Words. Lists. Word lists. Primitives of Operations of words and lists processing.

12. Objects of MicroWorlds environment

Programming of the Turtles, buttons, colour, sliders, text box as function (variable).

13. Dynamic graphics

Forms of the Turtles. Animation. Concurrent processes. Commands of suspending and termination a programme.

14. Technology of making a project

Sheets. Ways of text and image information output, answer input, frame change. Startup command. Making and protecting an individual project.

6. Methods of teaching

The main form of the course study is complex, for it usually contains a lecture part, work with training aids or an embedded reference-book, exercises and a laboratory work itself.

Methods of teaching being used:

- Explanations, discussion, work with training aids, dictionary, reference-book.
- Work with ready programmes (elements of demonstration sample method). (Boronenko T., Ryzhova N.,(1999), studying through problems (tasks).

Let us view examples of the tasks offered to students from the two dimensions:

- From stages of studying primitives on the example of one topic “Primitives of positioning”.
- On the basis of logic-pragmatic characteristics, offered in the monograph. (Bashmakov A., Bashmakov I., 2003).

Table 3. Types of tasks, used on different stages of primitives studying

Stages of study commands and functions	Type of the task	Examples
Recognition	Familiarization with the syntax and semantics of a command/function (particularly with the use of training aids and embedded dictionary of primitives)	Commands of absolute positioning: setpos sety setx Function: pos, <i>ycor</i> , <i>xcor</i>
Remembering	Making exercises with the use of commands being studied	Move the Turtle to different points with the given ordinates
Understanding	Comparing with the previously studied primitives, functioning in the same way (here in this case with the commands of move <i>forward</i> and <i>back</i>). Explaining the difference between absolute and relative Turtle positioning	The Turtle is in the specified point (for example 80, 40). Using commands of movement and positioning, place it in the point of specified ordinates (examples, 120, 40). The task is solved without computer utilization. The Turtle is in the specified point. Without computer utilization determine where it will be placed after the commands: fw50, back -50 nm [50 50]? Determine ordinates with the help of function.
Skills of applying to practice	Solution of tasks with accurately specified terms	Write down a programme, as a result of executing which the Turtle will be moved along the perimeter of the Sheet, “visiting” all the corners.
Systematization and summarizing	Solution of creative tasks	Write down a programme of generating a specified figure

Table 4. Types of tasks, distinguished by the means of logical character of thought processes

Tested knowledge and skills	Basic directions to check	Examples of formulation	Examples of specific course tasks
Notion	Determination	Choosing the most appropriate determination from the given ones	Definitions of the programming language
Relations between the notions	Types, classes	Determining specific difference between the notions	How do the notions Logo and MicroWorlds correlate?
	Correlation between extents and meanings		Correlate the meanings: programme, project, file, sheet, procedure
Object	Analysis of attributes and actions	Generation of the information model of the object	Generation of information model of the Turtle, a button, a text box
Operation	Purpose	Choosing a command or function, appropriate for the specific result	With the help of which primitive one can count number of words in a sentence?
Relation between the operations	Comparing	Commands, semantically close	Commands of branching: <i>if</i> and <i>ifelse</i>
		Pair commands and functions	seth and heading
		Ways of cycle organization	commands: <i>cycle</i> , <i>repeat</i> , <i>always</i> and <i>recursion</i>
		Ways of text and graphics processing	Visual and programmed

Text of programme	Analysis	Search for syntactical and semantic mistakes in the text of a programme without utilizing a computer	Read carefully the text of a specified programme. If you reveal mistakes— correct them.
	Decomposition	Execution of the programme in one's mind (without computer)	Without use of computer count the value of a variable after executing "calculation" procedure <i>to calculation</i> <i>make "s 0 make "n</i> <i>1repeat 8 [make "s</i> <i>:s + :n make "n</i> <i>:n + 1] show :s</i> <i>end</i>
	Analogy between different versions of the Logo language	Reading the text of a programme, written in the Logo Writer language, and writing it down in MicroWorlds version	
Show-examples	Identification of utilized commands, algorithm objects	With the use of which means dialogs and animation are being realized in the programme?	
Task	Setting up a task, programming	Making up an information model and writing down a programme	Write down a programme "Multiplication chart", which displays 10 pairs of different multiplicands in succession, and then – the product of these numbers
	Making up a programme without assistance	Think of and formulate a task, realizing parallel processes	
	2 way of single-step specification:		

	Top down	Write the programme "Race"	To race Start move End
	Down top	Write the programme "Tile" from the modules	
Algorithm	Conversion from one form to another	Algorithm is being reconstructed on the basis of the mind analysis	Analyze the text of a programme. Describe the algorithm of the task solution orally and/or graphically. The derived result present graphically.

7. Course "Information and communication technologies in Elementary education"²

In general the course is aimed at generating specific information competence of elementary school teachers. Logo in the course is viewed as the *professional* programming language, which could be rather efficiently used for writing pedagogic software tools (PST). Students analyze various resources of the Logo language, assess them, and choose the most appropriate ways of interaction realization, knowledge and skills control, us of the interface.

In particular, the following questions are being scrutinized:

Ways of output of educational information on the screen

Ways of answer input

Ways of checking accuracy of the input answer

Ways of output of response on the answer

Ways of frame changing

As a result every student creates a script and a fragment of a teaching programme in each of the subjects of the Elementary school curriculum. Below, there is an example of one frame programme in computer science in the 3rd grade, implemented by a 3rd year student of Elementary School Education Department tutored by V.Vorobyova (figure 1).

8. About the course "Methods of teaching of computer science"

Within the course we turn again to the Logo language yet from the point of view of its studying in grades 5 and 6 of Elementary school within the content line "Algorithms and Executors". Curricula and training aids are analyzed (completely or partly) devoted to the Logo language, problems of selecting topical content, compiling the task system, methods and ways of language study, possibilities of creating studying environment, providing

² At the moment the course is given by the two educational specialists - the author and lecturer of the Chair of the Computer Science V.Vorobyova

organization for elementary school students 'collaborative creative activity. Besides, Logo provides possibilities for studying different Elementary school subjects, first of all Mathematics, are being analyzed here.

An in-depth study of various aspects of the language has been made in several term-papers and diplomas. With active student involvement, the author has developed Elementary school curriculum in computer containing the part "Initial information on algorithms and work with the Turtle. Let us present a part of the programme and methodic directives for the teacher.

"Information Culture" (4th grade)

Topic. Working with a few Turtles

Purpose: forming skills of activating the Turtle visually.

Written task: making up and writing down algorithms of activation the Turtle and commands input.

Classroom work: the game "An active Turtle". Game terms: a few students go to the blackboard, turn off each other, "being activated" by touching them. The Turtle, when activated, makes the "forward" command.

Computer work:

1. On the sheet with previously prepared didactic means (a few Turtles), one is to activate each one and analyze the result.
2. On another sheet with didactic materials, children are to solve a few arithmetic tasks. The derived figures become input parameters for each of the eight Turtles. Then, it is necessary to activate each of them in order and put in the "Forward <n>" command for it.

Classroom work:

1. To describe the algorithm of solving a task: How to make a few Turtles move in different directions on different distance. Pay attention to multiple repetitions of the same operations.
2. Analyze the results of each of the eight Turtles.

9. Conclusions

While preparing would-be teachers of Computer science and Information Technologies for Primary school and in grades 5 and 6, an essential part is given to Logo language studying. In the course "Basics of Programming in Logo Language" students view it as *educative* programming language. In a special course "Information and Communication Technologies in Primary Education" Logo is viewed as one of the tools for realization of educative computer programmes in primary school subjects. Within the course "Computer Science Teaching Methods", students master methods of learning algorithms and programming languages when using the Logo programming language as an example.

Studying courses, scrutinized in this paper are to be developed further. In future, we are planning to create a distance course in Logo language. At present a book of problems in Logo language for the university and school students has been prepared for publication by A. Vitukhnovskaya and S. Kostyukova.

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