Logo from the Kindergarten to the University Level

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Abstract

Our main goal for teaching informatics from kindergarten to university level for children and for students is to make learning fun and motivating. Sometimes it is necessary to teach informatics without computer and sometimes with computer. One of the biggest advantages of Logo is that it can suit all ages.

Keywords: Structured thinking, problem solving

1. Introduction

Prof. Seymour Papert said in his book: "The Children's Machine" that the children who learn nowadays are the computer generation. Papert S. (1993). It is truer nowadays, when the date begins with the number two in the European calendars. The skills and abilities of children considered to be among the most important are: preparedness to solve new problems, sensitivity to problems, creativity and imagination, algorithmic skills, the ability to persuade others, short-time visual and verbal memory, directed attention, and concentrated attention. On the basis of our experiment conducted over the past twenty years in Hungary, we are convinced that these skills and abilities can be successfully developed and perfected using the pedagogy developed by Papert, using the Logo programming language and Logo-pedagogy.
The computer is only one tool and it is not the most important one. We have tried using several other kinds of information technologies. Computer and the other tools are only objects. Even in the age of informatics the child - as the learner - is the most important.
We prefer the problems which are solved in various ways, especially there is manipulating in that different ways. We help the teaching with trial and response, the individual study with multiple methods. This theses, is important both in early childhood and later. We in general use together in parallels the traditional and computerised methods of learning. The basis of our pedagogical research is improving while preserving previous worth. There are such didactic activities even today, in the age of computer, that may or should be played without computer, and the computer is only used for repetition and variation. As far as we concern the logo-pedagogy is more general than the computer. We accepted the advice of Papert: the turtle and his world is only one model among the possible microworlds Papert (1980). We are looking for methods, and devices with ones we can imitate and support the method of turtle. For that reason we use several team activity games, role-playing and manual activity games, which are very useful to introduce the concept of informatics.
In the next two paragraphs we are going to discuss the didactic line of our methods, later we shall discuss two elements of a method which are new in our concept. The use of Tangram in developing structured thinking is our example for it. In this case the computer is only of little consequence. On the other hand there are many fields of teaching where the using of computer is the optimal method. The demonstration of probability by the wandering of turtles is a good example for this.

2. The correct line of using our methodical elements

“One of the biggest advantages of Logo is that it can suit all ages.” Calabrese E. (1989). It is really true. This is the reason why we use Logo from the kindergarten to the university level. But of course the method, the way of using is not the same in the different ages. There is an optimal order from our own body to the computer.

2.1. Robot Games
Playing games is necessary at every stage of human life. Playing makes learning more enjoyable and successful. We start to work with the children’s own body, because knowledge about themselves is necessary before they can manipulate things outside themselves. Both teacher and children act as robots, which are given commands how to move. To introduce students to Logo, we developed “robot games” to help them act out what they will do later by using computers. Seymour Papert says that the ultimate mean of motivation for a child are the turtles, but we believe that students are more comfortable with the idea of a robot. A real turtle would think of obeying our orders, while a robot would always be faithful to our commands. We also think it to be important to “detach” young children from the computer-screen. Depending on the age of the learner, we give verbal instructions – first in Hungarian and later in another language. At first we use vocabulary from natural language: walk, turn, and so on, and then we gradually begin to apply some formal commands, slowly approaching Logo’s syntax and semantics. Children play as being the robot by performing each movement by word.
Before beginning the robot game we discuss the size of the steps to be taken and the unit of a turn. A step is usually a foot, and the unit of a turn for small children is a quarter turn. Later, at the end of the first or in the second class, it is 1/12 of a circle – we call this “one slice of cake”. At first we ask children to enact only the basic Logo primitives: FD, RT, BK, LT. Later we work on the interpretations of results. For example PD means that students will trace the path with chalk or use a branch to draw the path on the ground on the playground. Students create the equivalent of the HT primitive by crouching so that the hidden robots cannot be seen between the benches. The wall of the classroom or the edge of the playground can serve as the frame of the computer screen when students learn to interpret commands such as FENCE, WINDOWS, TRACK, and so on.
Later in the older student’s ages, when the founded problems were difficult, we make the students use their own body for understanding.

2.2. Feed the turtle
In the first level of the game, in our pedagogy usually play the “Feed the Turtle” game in the kindergarten. The other children direct Child who plays the turtle to the “feeding place”. They direct the child turtle by means of different Logo commands. The game provides very useful training in algorithms, as well as a sense of position and direction. In the next level of the game, in the primary school, students move figures they had made based on a model – a Turtlegarden. Later they use graph paper, abandoning the real world game and taking a decisive step from the real to the abstract. The students then copy the trail of the turtle in a copybook. After practising with the turtle Turtlegarden and graph paper, they start using a computer that has some model of the Turtlegarden they have been using in the game.

2.3. Match-Logo
In this game students operate a vector in a plane. They direct a “robot” along imaginary swampy ground, but the robot is able to proceed only after they have “paved” its way with arrows they have made themselves using matches or some other form of vector marker. The robot can only move in the direction of the “paving”.

2.4. Brick-Logo
Brick Logo is our name of the well-known LEGO-Logo. Brick-Logo is a pseudo-language that uses Logo commands to describe a three-dimensional turtle graphic. Students use Brick-Logo programming commands to move real objects in the real space, which helps develop their dexterity, visual response time, spatial reasoning, and algorithmic ability. The special advantage of the game is that it involves real three-dimensional space and for example is a very easy way to explain the laws of symmetry to students. One of our recent results of our research is that, the Brick-Logo can be used in the higher education, even it is an excellent test of the measure readiness to learn.

These elements: Robot Games, Feed the Turtle, Match-logo, Brick-Logo and the others of our repertoire: different types of floor turtles, robots, models, logodrio, Rubics cube, speed reading and Logo only some examples. Lot of them are well-known for the Logo community, and many other colleagues use similar methodology elements in his or her teaching. We conferred about these several times. Farkas – Kőrösné. (1989) (1991) and Farkas. (1994) (1996) Look the references!
These acts and the others have a large number of form, which depend on the age of the student. We always looking for new and new objects, which are comfortable to use like a logo microworlds.

3. Geometrical games - structured thinking

We hold the view that children should not be taught programming in public education, they should be taught structured thinking with the help of various games.
In elementary school (and even more so in the higher years of primary school) there is less and less time left for playing as there are few lessons and a lot has to be taught, "useful" things have to be hammered into the schoolchildren' heads. In this way the very exercises (the more entertaining ones), that could convince children that mathematics, geometry, or informatics can be interesting, are left out.
The general experience is that most pupils view exercises as an integral whole, and are unable to find a solution at once. Then they categorically state: "I can't do that.", and really, after this they are unable to solve the problem.
From the beginning of teaching information science, resourceful problem-solving thinking has to be emphasised.
"Great inventions solve great problems, but even the smallest problem requires some little invention. The problem you are thinking about may be simple, but if it arouses your interest, activates your inventiveness, and finally if you manage to solve it on your own, you experience the thrill and triumph of discovery. … What is realised of it greatly depends on the mathematics teacher. If the mathematics teacher spends most of his/her times making the pupils solve routine problems, he/she kills their interest, hinders their mental development, and turns the favourable conditions on their wrong side. He has to realise that solving a mathematics problem can be as enjoyable as doing a crossword puzzle, or a strenuous mental exercise can be as good as a game of tennis." Pólya Gy. (1957)
György Pólya's book was primarily written for mathematics teachers or students dealing with mathematics, but his words are worth bearing in mind for every teacher and are highly recommended to teachers of information science. And indeed, if we keep saying, for example, when teaching Logo: repeat it four times, fifty forward, ninety to the right, then joy of creation is lost. If Michelangelo carves chair legs, he is no more than a craftsman. We have to set a goal that can be achieved. We have to rely on our knowledge in carrying out the task. We would like to make the turtle draw the picture of a beautiful castle. At first sight it seems to be a very complicated task. But if we analyse the task and divide it into parts, it does not seem to be unrealisable anymore. We set about the task with pupils in the fourth form. We named the picture "The Enchanted Castle". In connection with it we had a chat about the Amusement Park, their holidays abroad. The lesson of information science is much more than teaching computer science only! While analysing the picture, we were "learning" new words: bastion, round bastion, citadel, and we formed the following structure:

Enchanted Castle
Sun (Moon)
Circle
Birds (Bats)
Semicircle
Building
Tower
Castle Wall
Tower
Wall
Rectangle
Window
Rectangle
Roof
Triangle

It was at the fifth level that we met the known geometric figures, curves. And then we only had to properly join them, and the picture was ready.

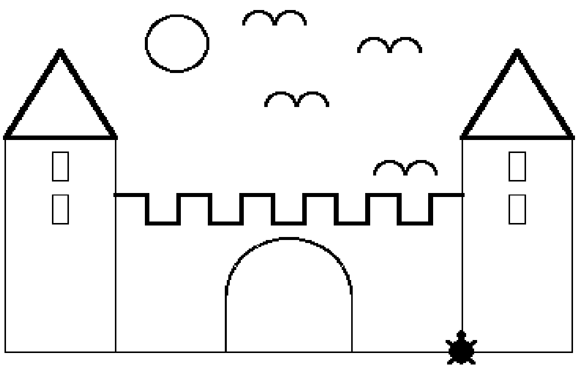

Figure 1: Castle

Similar structures can be realised by the well-known jigsaw puzzle called Tangram.
Since the ancient Greeks many scientist have been interested in the problem of cutting and joining figures. The statement of the well-known Hungarian mathematician Farkas Bolyai – father of János Bolyai, who constructed the non-euclidean geometry - is famous in geometry: if the area of two polygons are equal, one of them can always be divided into a finite number of polygons, out of which the other one can be assembled. An internationally significant mathematical achievement of recent years is connected with this topic and is associated with the name of a Hungarian mathematician. Miklós Laczkovich solved a problem set for over sixty years proving that a circle can be divided into a finite number of pieces and by rearranging these pieces we get a square the area of which is the same as that of the circle. Of course, the pieces cannot be cut out of paper, as the transformation of the circle into a square is impossible using pieces of ordinary edges.

Figure 2: picture of Tangram

Tangram is one of the most popular jigsaw puzzles. The aim of the game is to form various patterns: geometrical figures, animals, people, objects. Certain collections contain more than 1000 pictures: mostly figurative puzzles. Each starts with the division of a square into seven pieces. We cut out the seven pieces with the children using drawing paper with the help of a plastic model.

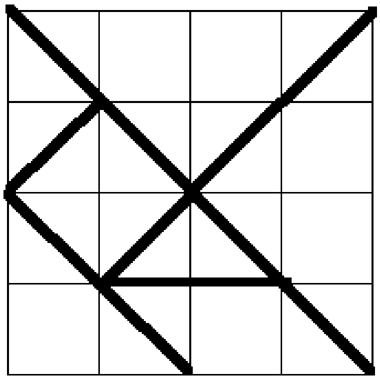

Figure 3: Tangram set

The "teacher's set" is made of coloured cardboard.
Tangram is very interesting from the point of view of geometry, but smaller children take more delight in assembling various figures. Many of them are real works of art, although the artistic value is at the expense of the puzzle. (The solution is too obvious.) In information science lessons not the level of difficulty is what matters, but the structure of pictures.
Of course, we started from reality here, too. If it is possible, show your pupils the original version of the task, or a picture of it. One of our best lessons was when we prepared the picture of a candlestick.
During the introductory conversation we spoke about the candle, holidays by candlelight. On such occasions it strikes you that some of the children are "belle esprit".
We made a picture of the candlestick.
In our presentation we are going to show our Tangram programme written in MicroWorlds. As far as we are concerned nowadays one of the best version of Logos is the MicroWorlds. We use MicroWorlds Pro.

4. The demonstration of probability by the wandering of turtles

The concept of chance and probability are often unclear even for students in higher education. Demonstration and gaining experience may be helpful here, too. The computer, namely the Logo programming language may play a significant part in it.
If you ask a student to put down ten one-digit numbers at random, the series of numbers is something like this:

1 7 4 5 2 8 3 9 6 1.

It means that the less experienced student tries to use each figure in a random sequence, but with roughly the same frequency. Whereas the result of

```
repeat 10[pr 1 + random 10]
```

command calls e.g.:

7 9 1 9 1 3 6 2 3 4

The wandering of turtles demonstrates the role of chance very well. We show some algorithms:

```
to butterfly
 fd 80 rt 60 + random 90 wait 2 butterfly
end

to cat
 fd 5 rt random 10 wait 1 cat
end

to formica
 fd 20 rt -10 + random 360 wait 2 formica
end

to boxes
 repeat 4[fd 120 rt 90] rt random 360 wait 2 boxes
end

to Mondrian
 setpensize 1 + random 10
 setc random 600
 fd random 100 rt  90 Mondrian
end

to trend
 repeat 1000[fd 3 rt 90 fd random 10 lt 90 fd 3 lt 90 fd random 10 rt 90]
end

to trend2 :d :k
 fd :d rt 90
 fd random :k lt 90
 fd :d lt 90
 fd random :k rt 90
 trend2 :d :k
end
```

The turtle helps for us to understand, to feel the random. These algorithms generate such curves which show dynamically regularity – irregularity in the random.

Later in higher education you may show the chance like Futschek does it, with the procedure MOVE. Futschek G. (1993)
In the higher education we model the random with the famous example, with the binary tree (adapted from Abelson, 1982) like this:
In the logo-society well-known the next recursive algorithm:

```
to tree :a :n
 if :n = 0 [stop]
 fd :a / 2 lt 45
 tree :a / 2 :n - 1
 rt 90
 tree :a / 2 :n - 1
 lt 45 bk :a / 2
end
```

The recursive description of the tree is a V-shape with a smaller tree at each tip. Each smaller tree is a V-shape with a still smaller tree at its tip and so on.
It is not necessary, that this algorithm, this curve let be symmetrical. The right and the left side let be changed with a multiplier and the reciprocal of that one. (In the example it is 1.2) In the nature the plants grow strongly to the light.

```
to tree2 :a :n
 if :n = 0 [stop]
 fd :a / 2 lt 45
 tree2 1.2 * :a / 2 :n - 1
 rt 90
 tree2 (1 / 1.2) * :a / 2 :n - 1
 lt 45
 bk :a / 2
end
```

Beside the point of the compass factor (in the next example it is 1.05) let another be which depend of the random:

```
to tree3 :a :n
 if :n = 0 [stop]
 fd :a / 2 lt 45
 tree3 1.05 * (.25 * (2 + random 4)) * :a / 2 :n - 1
 rt 90
 tree3 1 / 1.05 * (.25 * (2 + random 4)) * :a / 2 :n - 1
 lt 45 bk :a / 2
end
```

On the figure 4 you can see some calls.

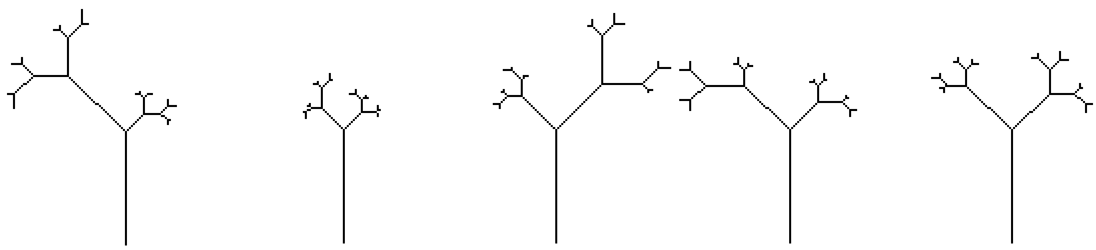

Figure 4: Binary random trees

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