

LOGOWORLD: A Learning Environment for The Logo Language

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Abstract

The rationale behind the choice of Logo-based microworlds is briefly discussed and then the attention is focused on LOGOWORLD, a microworld designed to facilitate turtle geometry learning: the latter is the microworld which most children use when they first begin to explore the Logo language. Learning turtle graphics becomes a pleasant experience for the child and yet while being safe this little world is designed to be discovery-rich: the child has the full power of the Logo language available to him and whatever the microworld furnishes is additional to that power.

1. Introduction

The "cognitive effects" hypothesis states that there is a close similarity between the building up of Logo programs and the building up of thought structures so that the cognitive development of the child is favourably affected. When a child constructs a Logo program he goes through a process which parallels that of thinking. Papert (1980) also asserted that this similarity between Logo-work and thought-work is what makes Logo a "tool to think with" in a way which most others programming languages cannot be. Chang (1989) reviewed and analyzed the Logo studies recently published: one of his major findings was that Logo had a positive effect on problem solving skills, metacognitive skills, reasoning skills, and learning of geometry. It is our opinion that nowadays Logo is by far the most powerful programming language available for educational purposes where "power" is, in Harvey's (1985) words, "a way of measuring how much the language helps you to concentrate on the actual problem you wanted to solve in the first place rather than having to worry about the constraints of the language".

We consider a "microworld" as a computer environment with which the child can interact and whose characteristics awake his interest by involving him both emotionally and culturally (Fischetti & Gisolfi, 1989). Microworlds are to be considered not as a mere piece of software, a program or a set of procedures: a microworld is also the "situation" in which it is embedded. It is also the suggested activities and the other resources involved. Obviously, the approach to learning, which was specific for Logo, has not to be neglected: it is vital the possibility to explore the microworlds and their intrinsic tool-nature.

This paper presents LOGOWORLD, a Logo-based microworld developed with the aim of facilitating turtle graphics learning to children. We set out to develop a microworld which maintained the spirit of Papert's (1984) description of turtle geometry.

LOGOWORLD is designed and constructed as a safe place for exploring, it will never fall to pieces and the child will never get into trouble or receive a low grade. It will never embarrass him, the child will never feel "stupid". Many mathematical ideas are inherent in turtle geometry, so children who have spent some time working with LOGOWORLD will have been engaged in many mathematical processes. They will have used a lot of mathematical notions, implicitly if not explicitly. However, the main goal of our microworld is to enable teachers to provide a safe and friendly environment in which children might focus their learning skills on turtle graphics.

2. The Structure of Logoworld

As regards the internal architecture of the microworld, it is a conventional one: several programs are contained into some files and each of them can, in turn, call other programs present in other files. It is more interesting to describe how LOGOWORLD appears to the end user. We note that the commands and the error messages are available in Italian so that children find an immediate correspondence between the information supplied and the moves carried out by the turtle. In the following, for the same of simplicity, the original screen pictures have been translated into English. Our planning was hinged on a turtle named Turty which takes the child to its world, i.e., the Logo world (Fig. 1).

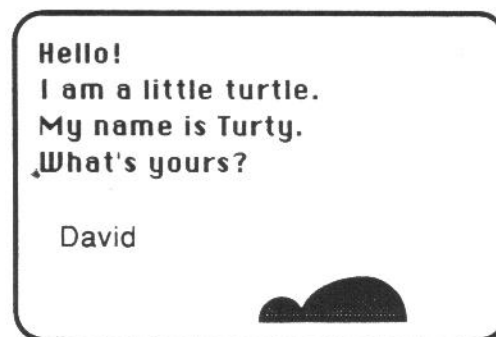


Fig. 1

Turty addresses the child directly so that he has the feeling that Turty takes care of him and encourages his exploration.

The microworld is organized in four sections. The second (the Tutor) is the central one, the others (Introduction, Glossary, Speaking to Turty) carry on auxiliary and consulting roles to facilitate child's entering the learning environment. In particular, the Introduction aims at stimulating child's interest for the turtle graphics, the Glossary can be consulted by the child whenever he needs specific information, Speaking to Turty allows the child having the full power of Logo language in order to develop his own programs. We discuss in the following

some relevant features of this world and, at the same time, we mention the invisible educational framework.

3. Exploring the Microworld

First, Turty goes for a walk and, in the meanwhile, shows the child some of the beautiful things present in its world, i.e. examples of turtle graphics. Turty starts drawing lines, afterwards some simple drawings are, step by step, constructed (houses, flowers, squares, triangles, etc.) and eventually we see quite complex drawings such as the flower (Fig. 2) which is generated by rotating a little house. Some examples show the child that simple building blocks can create more complicated objects. This first part, beyond the Logo graphic features, also emphasizes the ability of the language to run some palettes of several colors. It is worth stressing the importance of the colors to get both an attractive environment and an adequate stimulation of the child's problem solving skills. Thus this section permits to verify child's perceptive skill as well as to stimulate the visual memory skill.

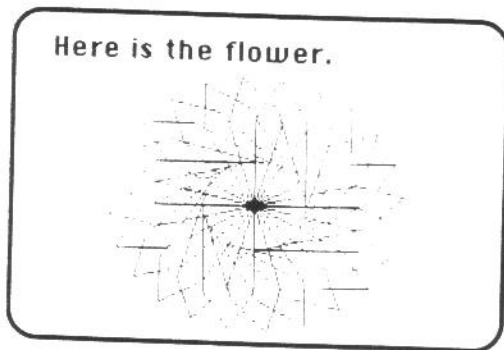


Fig.2

Then the child enters the core of the microworld, i.e. the Tutor, which is organized in four parts each devoted to a specific set of Logo commands. We stress that the child is first obliged to write in full the commands until a sufficient mastery is achieved and then short forms are allowed to him. Moreover, the tutor suggests a suitable learning sequence yet it permits the child to return to menu at will and to shift immediately to another topic.

1) Graphic Commands

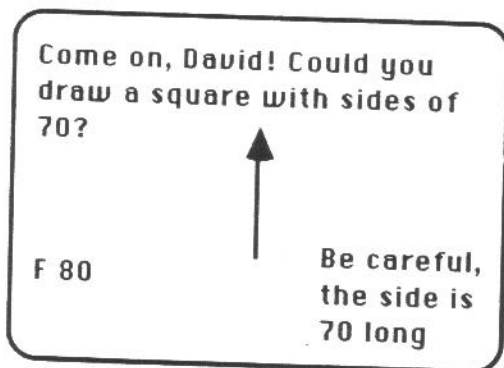


Fig.3

The basic Logo commands concerning the turtle moves are introduced. A specific goal, such as drawing a square, is pursued by means of a chain of subsequent discoveries. First, the commands FORWARD, BACK, RIGHT, LEFT are illustrated and then Turty suggests the child building up a square (Fig. 3).

The statement REPEAT is shown to be useful to shorten programs. This part of the microworld also intends to develop child's awareness of how he moves in the space. To this end some exercises are presented such as the problem of building up a fence around a house (Fig. 4); the goal is to develop the sense of direction and the distance evaluation skill.

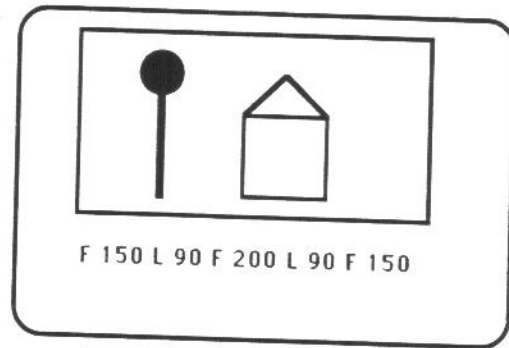


Fig.4

Furthermore, it is useful that skills such as the grouping and the classification, very important in the Piagetian theory, be adequately stimulated: thus Turty proposes a lot of suitable exercises, e.g. to re-arrange in the right sequence four circles of different size (Fig. 5). The microworld allows the child moving freely and yet being safe he can develop his own cognitive experiences by drawing many different objects.

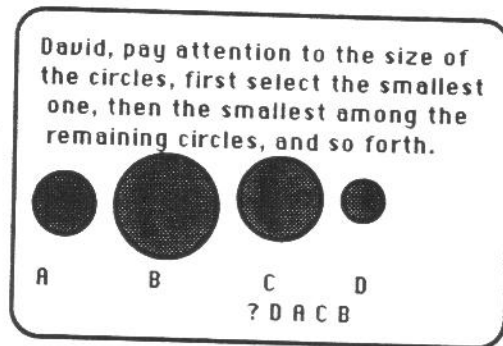


Fig.5

2) The Procedures

In this part the basic notions about procedures are gradually discovered by the child. The command TO permits him to define a new procedure or, in other words, "to teach a new word to Turty".

The child is induced to build up a little library of programs (Fig. 6) which shall constitute the building blocks of more complex programs. This planning aims at developing in the child suitable hierarchies of knowledge as well as stimulating his problem solving skills.

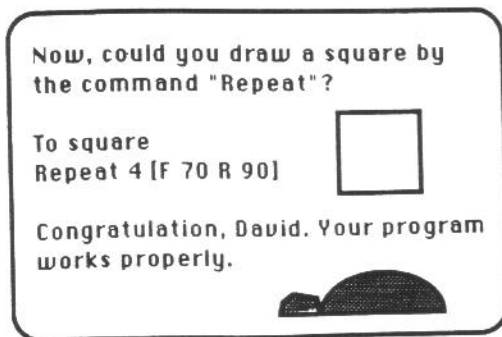


Fig.6

For instance, after having developed the programs SQUARE and TRIANGLE, the child might construct a program to get a stylized house:

```
TO HOUSE
SQUARE
TRIANGLE
END
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The execution of the program reveals the logical pitfall (Fig. 7.).

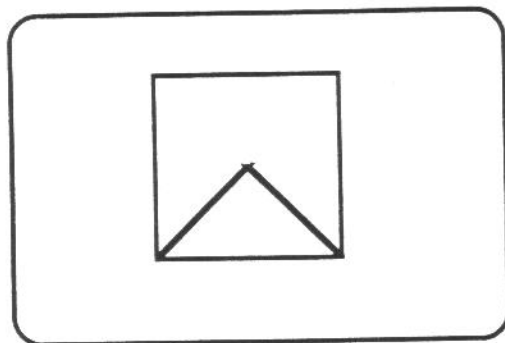


Fig.7

Obviously, LOGOWORLD does not blame the child for his mistake, on the contrary Turty encourages him in deepening the problem, so that gradually the source of the error is found and the program can be edited. The concept of recursive procedure is operationally introduced. Among several exercises suggested by Turty we quote the problem of drawing a circle. A possible solution is the following:

```
TO CIRCLE
FORWARD 1
RIGHT 1
CIRCLE
END
```

The program never stops: for the present it is important that the child can realize the power of recursion, later he will learn the control statements to stop the execution of the program.

3) Processing Words and Sentences :

Logo is more than mere turtle graphics; thus Turty tackles the problem of processing words and sentences. First, basic commands such as PRINT, FIRST, LAST are

illustrated (Fig. 8), later Turty suggests several exercises to develop the logical skills of the child; for instance, the latter is induced to construct meaningful sentences by choosing the words among those offered by the microworld (Fig. 9).

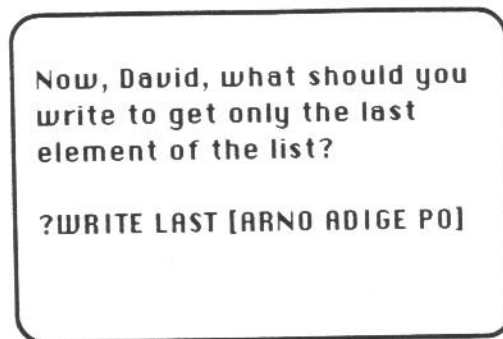


Fig.8

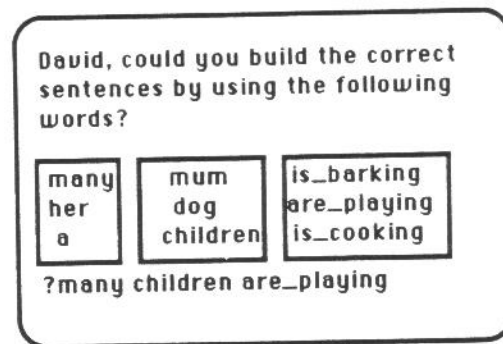


Fig.9

It is duty of the tutor to check the grammatical correctness of the sentences and to point out possible mistakes.

4) More Advanced Commands

The last part of the tutor illustrates the most powerful features of Logo and shows the child the advanced commands available to the programmer. The child gradually discovers colors, backgrounds, etc. and learns commands such as OUTPUT, IF, MAKE;

For example, the importance of the command OUTPUT is illustrated by means of randomly generated sentences having a definite grammatical structure: some of the words are furnished by Turty, the others are chosen by the child, and afterwards the resulting sentences are shown; obviously many sentences are meaningless yet they are taken as starting point for the analysis of the sentence and for its subsequent correction.

In a similar way other advanced commands are illustrated so that their full understanding is gradually achieved by the child. For instance, the command MAKE is first exemplified in simple situations and, step by step, more complex problems are tackled. An example is the program CIRCLE previously constructed that needs some editing to stop its execution.

```

TO CIRCLE
FORWARD 1
RIGHT 1
MAKE "S "1
IF :S = 360 (STOP)
MAKE "S :S + 1
CIRCLE
END

```

Furthermore, Turty shows the child some incomplete or incorrect programs and asks the child to insert the suitable commands into the programs (Fig. 10).

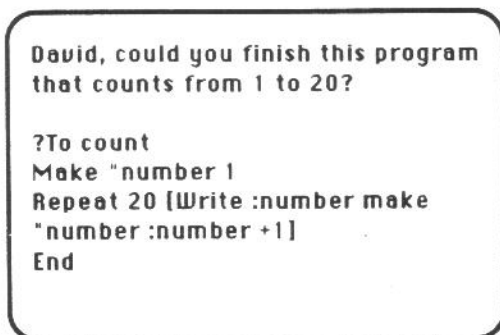


Fig.10

The correct use of the colors is achieved by means of simple exercises (Fig. 11).

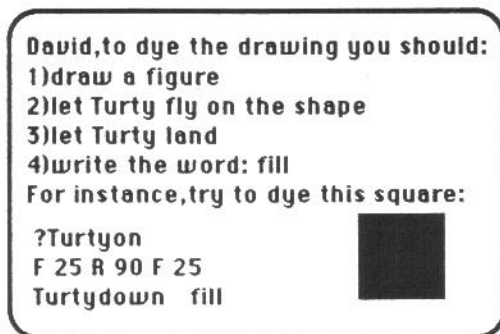


Fig.11

Afterwards, the child is asked to dye quite complex objects such as Turty's home. Finally, some problems test the effectiveness of learning by the child: for instance, the exploration of a maze (Fig. 12) is an appropriate test to verify his mastery of changes of position in the space.

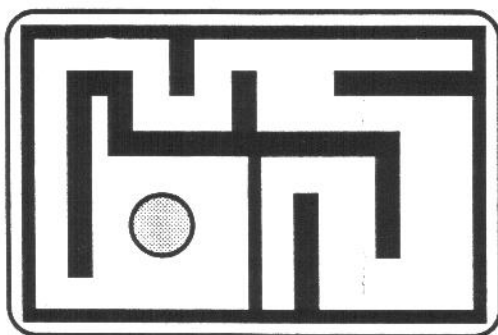


Fig.12

In this last part it is taken for granted that the child possesses adequate mastery of the Logo logic: if the child is unable to solve the problems Turty will friendly suggest him going back to the previous lessons to get full understanding of the necessary prerequisites.

Concluding Remarks

So far LOGOWORLD has had only limited use in classrooms, but the responses from both teachers and children (between 7 and 10 years old) suggest that most aims have been attained. Some problems appear during the testing: for example, when the child stops simulating Turty on the floor of the classroom, his sense of direction has to tackle the vertical plane of the monitor and this fact can cause slight problems to some children. Moreover, some pupils are in trouble when the simple action of turning right or left has to be divided into two separate commands.

A more comprehensive study is under way in two experimental classes, C1 and C2, where the subjects are children 10 years-old. A 60-hour Logo course is being taught in both C1 and C2 by the same teacher. In C2 the teacher is supported by LOGOWORLD.

Qualitative evaluation of the teaching experiment emphasizes that for many children to acquire a sufficient level of Logo knowledge, without textbooks, is a pleasant experience. We note that creativity appears growing faster in the C2 group and, moreover, children are encouraged by Turty to explore other available microworlds (geometry, algebra). Finally, the teacher is appreciating the "partnership" of Turty since it helps him to manage children's learning skills so that classroom management becomes easier.

Although more extensive testing is desirable in order to determine conclusively at what extent LOGOWORLD is an effective means of Logo learning, we observe that when children use the microworld they work at a level of complexity and a rate suited to their personalities.

Furthermore, they enjoy this activity as they are not pressurized by external factors. In conclusion, the results of the present study are rather encouraging and furnish significant evidence of an useful microworld experience at primary school level.

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