DOCUMENT RESUME

ED 118 366   SE 019 896

AUTHOR   Perlman, Radia
TITLE   TORTIS (Toddler's Own Recursive Turtle Interpreter
                 System).
INSTITUTION   Massachusetts Inst. of Tech., Cambridge. Artificial
                 Intelligence Lab.
SPONS AGENCY   Advanced Research Projects Agency (DOD), Washington,
                 D.C.; National Science Foundation, Washington,
                 D.C.
REPORT NO   LOGO-9
PUB DATE   Mar 74
NOTE   11p.; For related documents, see ED 077 236, 240-243,
                 SE 019 893-894, and 897-900

EDRS PRICE   MF-$0.83 HC-$1.67 Plus Postage
DESCRIPTORS   *Activity Learning; Artificial Intelligence;
                 Cognitive Development; Computer Based Laboratories;
                 Computers; *Early Childhood Education; Interviews;
                 Learning; *Mathematics Education; *Problem Solving;
                 *Research
IDENTIFIERS   *Massachusetts Institute of Technology; MIT; Research
                 Reports

ABSTRACT

        TORTIS (Toddler's Own Recursive Turtle Interpreter
System) is a device which can be used to study or nurture the
cognitive development of preschool children. The device consists of a
"turtle" which the child can control by use of buttons on a control
panel. The "turtle" can be made to move in prescribed directions, to
take a given number of paces, to draw, to toot, to turn its light on
and off, and to remember or forget. In this paper, protocols for
several children who interacted with the turtle are informally
summarized and discussed. (SD)

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

A. I. LABORATORY

LOGO MEMO 9.

March, 1974

TORTIS

Toddler's Own Recursive Turtle Interpreter System

by

Radia Perlman

INTRODUCTION

TORTIS (Toddler's Own Recursive Turtle Interpreter System) is a device for preschool children to communicate with and program the turtle. It consists of several boxes (currently 3 button boxes and two blox boxes) designed so that only a few new concepts are introduced at a time but more can be added when the child becomes familiar with what he has. Hopefully transitions are gradual enough so that the child never thinks talking to the turtle is too hard or that he is "too dumb." And hopefully playing with the system should teach such concepts as numbers, breaking large problems into small solvable steps, writing and debugging procedures, recursion, variables, and conditionals. Most important of all, it should teach that learning is fun.

I am hoping that the blox box is sufficiently advanced so that the transition to logo will be easy. And I would like to expand the system to include programming music also, as the children seem to enjoy noises more than drawing. I am not sure of the best way of doing this yet and ideas are very welcome.

DESCRIPTION OF THE SYSTEM

The turtle is a disk about one foot in diameter equipped with a light, horn, and pen. It can move forward, backward, or rotate about its center (where the pen is). When the pen is down the turtle draws as it moves.

The first box the child sees (the small commands box) has nine buttons: "forward", "back", "right", "left", "toot", "pen up", "pen down", "light on", and "light off". Each button evokes an immediate response from the turtle. Next the child is given a larger box (the commands box) which has a top row consisting of the buttons on the small commands box plus a bottom row of numbers from 1 to 10, and a "stop" key. The action buttons still evoke an immediate response but an action button preceded by a number button causes the action to be executed that many times. "Stop" interrupts the turtle immediately.

The next box (the memory box) consists of four buttons: "start remembering", "stop remembering", "do it", and "forget it". This box plugs into the side of the commands box. Pushing "start remembering" causes a screen to light up and thereafter lists all commands. "Stop remembering" stops adding to the list (goes out of

3

remember mode). "Do it" executes the commands in the list. "Forget it" clears the screen. This enables a child to define one procedure, but not to edit it.

The blox box will hopefully exist within a few months. Commands are (instead of buttons) blocks. On the top of each block is a picture representing the command. The blox box provides an array of holes in which to place the command. There are five rows of 16 command positions. Above each command position (except the leftmost of each row) is a lighted pushbutton. The light indicates where the turtle is. If the light is on above some particular hole, the turtle waits until there is a block there and executes the command represented by the block. Then the light moves over one position to the right. Pushing any button causes the turtle to stop whatever it is doing and start where the button was pushed.

Each command position actually consists of three holes of different shapes. The large hole is for a command, (like "forward") the narrow rectangular hole is for an optional number block, and the small hole is for an optional conditional block. The conditionals are "if front is touching something", "if back is touching something", "if right side is touching something", and "if left side is touching something". (The turtle has touch sensors for testing these conditions.) The leftmost hole in each row is for the purpose

of naming that row as a procedure. By placing a red block in that position, for instance, one can call that procedure by placing a red block elsewhere. (perhaps it should be legal to redefine the basic commands by using them as procedure names like in smalltalk.) Name blocks are the same shape as command blocks.

The other main concept in the blox box is variables. Part of the system will be a scope on which will appear five differently shaped polygons, each with a number written inside. For instance, triangle might have "3" inside. If it does, then using the triangle block (shaped like a number block) to make the command "triangle forward" causes "3 forward" to be executed. Values can be stored in triangle with the "store into triangle" block, shaped either like a command block or vaguely like a "T". The block shaped like a "T" allows room for two number blocks and an arithmetic operation block to facilitate commands like "store 3+5 into triangle" or "store triangle+2 into triangle".

The blox box may sound complicated but the child once again should be introduced to new concepts gradually. At first he will see only one row (the small blox box consists of the top row of the large blox box as an independent entity) and have only command blocks. Then he can be introduced to number blocks. Then in whatever order is experimentally determined as best (though one at a time) he can be introduced to the large blox box, variables, procedure names, conditionals, and T-shaped value storage blocks and operations.

HOW TO PLAY WITH A CHILD AND TORTIS.

The main quality one needs to help a child play with the button box is common sense. It is possible to make mistakes though,

4

since I have watched people "teaching" the preschool children who were so abominably bad that at least one child refused to move when her "teacher" was in the room, and others started crying when their "teachers" yelled at them for "having fun, not learning."

The philosophy of the button box is that only a little bit is shown to the child at a time, more buttons (and later blocks) being added only when the child is sure of the previous set. It is important that the child never feel that he is "too dumb" to learn or that the button box is "too hard" for him. Thus it is important not to propose problems to the child that he cannot easily solve. In the back is a list of "projects" in approximate order of difficulty.

I have found that the child, if left on his own with the box, often gets into a "loop", for instance hitting "1 toot, 2 toot....etc." over and over, finally getting bored. While there is nothing inherently wrong in tooting thousands of times (assuming no nervous homicidal adults trying to work next door), it is a good idea to give the child other things to do before he gets bored. It should not be an obsession, though. If the child wishes to play with what he knows for awhile it is not necessary to introduce new things. For instance, one boy was trying to draw and found it more convenient to not use the number buttons. This worried his mother (who was watching) because she thought he wasn't learning enough or something, and she kept nagging him to use the numbers.

I have tried letting more than one child play with the box simultaneously and that usually does not work. It is extremely important that only one child at a time hit the buttons, since having another person pushing the buttons gets confusing if the child does not yet understand the box and frustrating if he is trying to draw. The child must be in command. The teacher may make suggestions but it is up to the child whether or not he follows suggestions. And he should not have to fight off brothers, sisters, parents, and random outsiders in order to play.

There are two settings in which I've used the button box. One is in an office with relatively few other distractions. The child had an appointment and it was clear that that hour was "turtle time." This environment worked well. The children stayed interested about an hour usually. Left alone in the office older children (5 or more) managed as well as with a teacher and younger children lost interest quickly. One flaw in this environment, I felt, was that the child

could not take a break, since the mother was usually there and decided to take the child home at first sign of fidgeting. Another is that the child might have felt uncomfortable in such a strange setting, though I think most of them got over that quickly. Another problem was too many adults. Many people would pass by and come in to watch as well as parents who were there originally. So many people even make me nervous and it certainly bothered the children. Parents were especially bad since they were anxious for their child to appear smart and consequently nagged at the children to go onto new things and yelled at them for giggling. Parents were a help when they had the right attitude, however, suggesting projects, laughing with the kids, playing with them, etc. The next section contains descriptions of some sessions under these conditions.

Another setting, was a nursery school. It was a very unstructured one. The children were taught to share everything and there was extreme group pressure against playing with a toy and not letting other children share it. The result was that (with a few exceptions) the children all bunched around the box and fought over the buttons for a few days and then lost interest. When I tried to let one child use the box at a time, everyone else stood around complaining (very unnerving to the kid trying to play with the box) and insisted on being allowed to play with the terminal, turtle, and telephone while the other child played with the box, which of course made the box useless. A few children occasionally played with the turtle after that but I was fairly sure that setting was not conducive for using the box. The setting I attempted to try next was a very large nursery school (about 80 children) with a separate room for the turtle. Children would be brought up to play in groups of 1,2,or 3 whenever they wanted to play. Various problems (irrelevant here, like the equipment would not be locked at night, etc.) prevented my implementing it however. I'm not sure what the best environment would be. It seems clear that with younger children you need an entire adult (not divided by other responsibilities during turtle time) and very few children at a time.

It is probably more fun to the child to figure things out on his own. You can act like you are learning with him, "Gee, let's find a button to do that. Does this?..." but should not explain too much. A good way to help him learn is to get him to tell you what each key does. If he has problems getting the turtle to do what he wants, play turtle yourself with verbal commands from the child. If there are still problems, get the child to draw the figure he wants and have either you or the turtle trace that path.

Most important is to have fun (or at least act convincingly like you are). Act excited, praise the child, never criticize. A four year old's job in life is to have fun, so help him do his job.

EXAMPLES OF A FEW SESSIONS

John just turned four years old. He was very shy at first and would not go over to the box without his mother. After she hit a few of the keys, he gradually got more and more interested. After ten minutes he was totally comfortable with it. He narrated all his actions like, "Now I'm putting the pen down so the turtle can draw." "Now I'm putting his light on so he can see." At one point, the right wheel started rubbing a bit so I fixed it. He said, "That's because real turtles don't have wheels. They have legs." He was very happy and was giggling and chattering along with everything, but his mother kept saying, "Don't be silly, John, or I'll take you home."

He would hit 5 toot and count along with it and explain to me that it tooted 5 times because he hit 5. He also thought it was a lot of fun to stop it before it was finished.

His mother was very aggressive unfortunately. When I told her afterwards that John seemed very smart she said, "That's really a relief. I was afraid he would not seem as smart as the other children who had come here." Anyway, with that attitude she constantly kept urging him to do different things. So she would say, "But that's so slow!" every time he hit a motion key, since he did not seem to like

to use the number keys with the motion keys. When she said that he would invariably hit a 10 next time. I'm not sure whether that confused him. He might have thought that the numbers controlled the speed instead of the distance. Or he might just have preferred not bothering since he could keep the turtle moving more steadily by pressing a single key than by reaching back and forth between two of the.

The first problems he solved were moving the turtle to arbitrary points in the room. He also tried making the turtle unroll the paper by backing away a little and pushing 10 forward. He only discovered that stategy after a lot of experimentation.

After about an hour John was told that he had to go and wouldn't he like to come back some other time. He said, "No, I want to stay." Nevertheless, his mother took took him home.

He came back a week later. He seemed to retain everything he had learned the first time. He tried to draw a square and ended up with a triangle. He was not unhappy with it, though. I showed him the memory box and he filled the screen a few times but was not watching the turtle while he did that. After that, though, he ignored those keys and played only with the others. A 12 year old friend had come with him and tried to get him to play with the other keys. She

really interfered saying, "Push this key. Now push that one." John lost interest about then and his mother took him home. That session lasted about a half hour.

Susan was the first child I worked with. She is 4 1/2 years old. Her mother told me she was a slow learner with a short attention span and was a little afraid to bring her here. She said she didn't know how to count very well, just recognized a few of the numbers.

Susan was afraid to hit any buttons without knowing first what it would do. She was very afraid of making a mistake or getting people around her angry. She would keep saying things like, "Which button should I push now?" If I asked questions like, "Can you make the turtle come over to us?" she would often automatically say no. She did get excited by the toot with the numbers. She did not really know the numbers. (She recognized "1" and "5" and called "10" eight) But she realized that if she hit "7" she could count up from "1" until the key she pushed to find out how many times it would toot. She also enjoyed stopping it with the stop key and would say, "I told it to toot this far over but I stopped it here." The concept excited her so much that she did it over and over and then took the three pennies she had out of her pocketbook and placed them over the keys (starting at 1) and said, "I have that many pennies."

During the first session she also learned to control the light and pen. She also could make the turtle move in a straight line, but she never tried using numbers with the forward or back keys. Even after I showed her how it went further after pushing "10" forward she still continued pushing only the motion keys. (However she always used numbers with "toot") She did not understand the turning keys at all. When I asked her to describe what the turtle did when those keys were pushed she said, "It moves." I asked her if it moved the same way as when forward or back were pushed. She said,

"It doesn't draw a line when those are pushed."

The first session lasted about 45 minutes. At the end I drew a square and asked her if she could make the turtle go into a square. (Not draw one, just move into that place) She then decided she wanted to draw, herself. Shortly after that her mother took her home.

During the second session I had two serious hardware problems. First, the right wheel was not moving very well. (consequently, forward and right resulted in the same movement,etc.) Also the computer would sometimes spew several characters to the turtle. The problems got steadily worse throughout the session. When I had tested it before she came, the few times it did the wrong thing I assumed were freak accidents (like line noise). Otherwise I would

have cancelled the session. However it was interesting for a few reasons. She got very interested in the hardware. She screwed and unscrewed the lightbulb and kept asking why the turtle was sick. Unfortunately she became totally confused about the motion keys. The second session lasted about one half hour.

The third session went somewhat better. At least everything was working. She did get to understand why it was necessary to turn the turtle and she did occasionally use numbers with the motion keys. Her favorite thing was the tooting. I think she liked it because she really understood it and liked the power of knowing exactly how to make the turtle do what she asked. The third session lasted about a half hour.

The sessions were about two days apart. She seemed to retain most of what she had learned from one session to the next. She would insist she did not want to go home but she would want to draw or run around or play piano for a while. It is unfortunate that the way everything was set up, the child could not take a break, since the mother's time was tied up the whole time the child was here.

Kate is Susan's 6 1/2 year old sister. She is already in the first grade. She had no trouble with anything on the box. She even knew whether to push forward or back by checking the turtle's frame of reference. She was not quite as good on the turning keys. If I asked her to think first she usually picked the right key. Otherwise she would randomly pick one and switch if it was wrong. The first game she played was chasing me around the room with the turtle. Finally I turned it facing opposite me, and said, "Well at least it will take you awhile to turn it around this time." She said, "No! I'll back it up." So she pretty much understood everything. Then she tried "parking" it under the chair which required backing off sometimes in order to proceed further in. This took her a long time to figure out but she finally succeeded. Then she tried drawing. She was not too satisfied with her attempts, mainly because she couldn't erase mistakes and it was hard for her to judge angles with the turtle sitting on top of the drawing. She always used numbers with the motion keys. She did sometimes make mistakes on right and left. If she wanted to move left about four steps and she pushed 4 right instead, she would invariably first push 4 left to correct and then another 4 left instead of pushing 8 left.

After about an hour I gave her the memory keyboard. She

understood that easily. And she realized that by drawing a few lines randomly and pushing 10 "do it" she made pretty pictures because of the symmetry. She was still very much interested after two hours. However her mother was getting tired enough so that she had to leave.

Marsha was the youngest child I've worked with so far. She is 3 1/2 years old.

The first thing she discovered was the "toot" key. She went up through all the numbers hitting 1 toot, 2 toot, etc. up until 10 toot, counting along with it. Then she turned the light on and off. At first she always used a number with the light keys but then just hit the keys. The pen commands puzzled her and she asked what they did. She liked the noise and couldn't understand why it made no noise the second time. (penup does nothing if the pen is already up) She had trouble when turning the turtle around since if she used numbers she would forget whether it had been right or left she had pushed and she would push the other one. After a while she discovered the scope and pressed all the numbers, watching them appear there. Then she pressed buttons and looked at the words.

She had a lot of difficulty making the turtle come to her. She pressed different keys almost randomly. She was really surprised that back didn't mean come to her, since it pointed to her. Eventually she discovered an algorithm that worked. She would push a turning key until it eventually pointed approximately where she wanted. Then she would push either forward or back and correct if it did the wrong thing. She really had trouble adjusting to the turtle's frame of reference.

She did solve the problem of getting the turtle to an arbitrary point on the paper, though awkwardly. I then suggested she try to make the turtle draw something, like a square, After much trouble she eventually got about three sides drawn, but she could not get the turtle to make the last side by getting back to its original position.

After about 45 minutes she said she was getting tired and wanted to play with something else.

Patty is 4 1/2 years old. She was afraid to push keys unless she knew what they would do, but she was not shy. She continuously asked questions, sometimes to ask what a key did and sometimes to find out which key would do what she wanted.

She also had trouble with adjusting to the turtle's frame of reference. She continued to ask questions like, "What button makes it go there?" pointing in a direction perpendicular to forward and back. She used the number keys with the motion keys. She tried drawing a square but it came out very lopsided.

After about 1/2 hour her brother decided he wanted a chance.

She let him have a chance but she said she could hardly wait until her next turn.

At this point she had a chance to watch the scope. She suddenly noticed a word she recognized when her brother hit "light on," and called, "hey wow! It made a word that spelled 'on'." She asked him to push all the keys so she could see what it would write.

She got her turn again after about 1/2 hour. She got really excited about the scope and wanted me to read everything it said. When she eventually started remembering things she'd tell me what it said. The only words she had known were "up," "down," "on," and "off." She also knew the numbers. She complained that "0" looked like "8." The slashed 0 was confusing her a bit.

Since she was so interested in the scope, I let her play with the memory box. She was not interested in using it to make the turtle remember. She just liked having more words to find out about.

Eventually she went back to drawing but ignored the memory box. She improved somewhat on her previous square.

She went home after almost three hours (but her brother had played with it some of the time.)

Bobbie is 6 years old. He is Patty's brother. He had watched his sister at first and started right in. He had been very critical of his sister. "Let me go. She's not drawing anything good. She's just playing." I asked him if he would like to draw a square. He had previously noticed the memory box and asked about that. He really wanted to see that first. I showed him how it worked. He tried filling the screen. He couldn't really understand what was happening so he got discouraged. "I am not smart enough for those." I said not to worry about it, I'd show him again later. He tried drawing a square, but in the middle wanted to try to draw a robot instead. I gave him a pen and told him to plan what he wanted it to look like. He got engrossed in drawing, which gave his sister a chance to use the box again. He wanted to find out how everything worked. When I told him a computer was getting the characters and translating them into something the turtle could understand, he wanted to see the computer. He went for a tour upstairs. Afterwards he wanted me to give him some wire so he could build something electrical. I looked a little worried or something, because he quickly added: "I won't try to build a computer. Just something little."

His main problem was he was so excited and wanted to do everything at once. He was worried about not having much time, and there were so many things he wanted to do.

After almost three hours, their mother took them home, but they both said they wanted to return.

THINGS TO DO

1) turn light on and off

2) turn turtle so he can see the light

3) turn turtle to show the light to someone else in the room

10

4) explain what each button does. (especially the motion ones) If he says, "it moves" for both forward and back or "it turns" for both turning keys, try to get the child to describe the difference between the buttons

5) move turtle to arbitrary points on the paper (perhaps by placing several bowling pins around and having the turtle knock them over)

6) get turtle to chase someone (It would be neat to have two children, two boxes, and two turtles and get them to play tag)

7) get turtle to draw when it moves

8) move turtle to clean spot on paper (involves lifting the pen)

9) draw figures like squares, triangles, (discourage circles) letters, numbers, etc.

10) draw child's name (lifting pen between letters)

11) connect the dots on some surprise drawing you prepare

12) park the turtle under a chair

13) draw dotted line (in response to this, one 4 1/2 year old child made the procedure "penup pendown penup pendown penup pendown penup 10 forward" and said "10 do it." The adults watching were about to protest that that was wrong when we all realized that that procedure (because of the flare pen leaking into the newsprint paper) produced a line of large dots.)

14) introduce memory box

13) teach turtle to draw something so that "do it" does it

14) make pretty symmetry by repeating something a lot

15) make a short square procedure (realizing all you need is forward and turn)

16) teach everything they know about box to sibling or friend or any available kid (like a passing faculty member)