Mathematics, Education, PLATO, and Some Thoughts On the Future

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Overview

This brief article will review some of the mathematics materials currently available on the PLATO* system. In addition, some general issues related to mathematics education and computer-based instruction (CBI) will be addressed to provide thought-provoking ideas for future consideration. The article will begin with several of the author's biases, proceed with a discussion of PLATO CBI, move to math lessons on PLATO, and conclude with some thoughts on the future.

Author's Biases

Bias #1

Educators have not begun to scratch the capabilities of CBI technology in the learning environment. There is far more technological power than has been applied pedagogically. The two primary reasons are that CBI is poorly understood, and developing challenging lessons of quality places heavy time demands on classroom teachers.

Bias #2

Computers in schools will not simply be another technological "flash in the pan"; instead, they will eventually revolutionize the education process. The reason is that of all the instructional technology to be developed, the computer stands alone in the capability to interact with the learner on an individualized basis. All other media transmit information to a group while the computer is capable of interacting with an individual. Student learning is significantly increased by emphasizing processing over reception learning.

Bias #3

The coming of CBI will be a revolution rather than an evolution. Educational innovation takes 50 years to become used on a widespread basis; high technology takes 20 years. Since CBI is a blend of educational and high technology, one can expect full acceptance between 20 and 50

* PLATO® is a registered trademark of Control Data Canada, Ltd.

years after discovery. It is significant that PLATO is approximately 20 years old at this writing.

PLATO

When evaluating any CBI project, one must consider these five factors: personnel, software, courseware (instruction to be delivered), hardware, and telecommunications. The PLATO system is the only major CBI system with these features that was designed specifically to be used in the instructional process. As an example, the PLATO terminal is human engineered for high-quality instruction. It includes such features as high-resolution interactive graphics, touch panel, special function keys (for example, the HELP key), and built-in intelligent microprocessors.

The University of Alberta purchased and has operated a PLATO system since autumn, 1980. It is used to deliver and prepare CBI for the university and educational institutions across the province. A major reason for the selection of PLATO is its superb software facility that supports the development of courseware. Fifteen projects to develop university courseware are currently under way.

The university PLATO system is one of five university-based installations in North America. Together, they serve over 250 colleges and universities. Many of these institutions are actively engaged in courseware development across hundreds of subjects and all grade levels. Control Data is developing an extensive body of courseware which it markets to educational and training institutions. Mathematics for junior high, senior high, and university level training enjoys special attention in the total courseware list. It is estimated that there are 20,000 hours of courseware available across all PLATO installations worldwide. Courseware development of this magnitude represents a significant investment of human and machine capital, and will affect education and training.

Mathematics on PLATO

Due to the decentralized nature of the development of mathematics (and other courseware) lessons, it is impossible to know the number of lesson hours currently available. My estimate is 2,000 hours = 500.

In a completely nonrandom sample search, I signed on to one of the several of PLATO's on-line catalogs to request information on mathematics lessons. Figure 1 lists the lesson titles found on initial search. One can see the extent of material uncovered by this highly limited search.

Each entry is arranged in a tree-structure format such that typing in the number will display additional information about the lesson topics. For example, additional information on the topic "Mathematics, elementary, Academic Library" (Figure 1, entry no. 50) resulted in the extended listing found in Figure 2. After 20 lessons, I discontinued the search and requested more detailed information on the lesson "Decimal Darts" (Figure 2, entry no. 20). Figures 3a and 3b present detailed information on "Decimal Darts" including lesson information, intended audience, description, and goal. Finally, I signed on to the "Decimal Darts" lesson. A sample of the interaction is shown in the sequence of Figures 4a - 4e.

In Figure 4a, the PLATO program (actual screen display) presents a vertical number line with balloons. The student is to type in the decimal value of the location of each balloon in the lower left-hand corner of the screen. In Figure 4b, I typed in ".11" and pressed the NEXT key. A dart moved across the screen and stuck at position ".11" (see Figure 4c).

At this point, I exercised the option of having PLATO shoot a dart (see text, lower right-hand, Figures 4a - 4c). The result was a dart which stuck at ".103," Figure 4d. Finally, a dart was shot at ".15," resulting in the bursting of a balloon, Figure 4e.

This practice assists a student in interpolating positions on a number line. Furthermore, the difficulty of the problem can be varied under program and/or student control. When finished, the student receives a summary of his or her performance with the option to continue practice.

Some Thoughts on the Future

Goals of Mathematics

Two broad goals of teaching mathematics include the learning of mathematics per se and the learning of logic, an organized way of thinking about the world. Current mathematics instruction, with its instructional strategies of tutorials, simulation, review and drill, games, and diagnostic/prescriptive testing/record keeping has focused almost exclusively on the former goal. Microcomputers in education will certainly enable us to focus on the development of logical skills. *Mindstorms* by Seymour Papert reports on a major project to do the latter using computers with young children.

Three proposed benefits from Papert's work will be cited. First, the student will learn to debug programs. The significant point here is that errors and mistakes will not be viewed as failures but rather as challenging problems to be solved. Second, students will come to use the power of recursive functions and integrate loops in their thinking about other forms of math-related operations. Third, learners will become more prone to do intuitive error checking to estimate the reasonableness of their work. By contrast, the error checking that is driven by discovering that one division problem in 20 does not have an integer quotient is a false, human error check.

Curriculum Goals

Papert has argued that much of what is taught today is dictated by the limits of paper and pencil technology. Plotting of quadratic equations and long division are two examples. The imminent availability of cheap computing technology will eliminate the need to do these computations by hand. A pressing question for educators is what new curriculum components should be added to replace these existing skills. This topic is expanded in the following section.

Demise of Schools

Papert and others (for example, Lewis, 1980) have predicted that the presence of computers in our society will enable us to modify the total learning environment of the student in such a way that schools as they currently exist ". . . will have no place in the future" (Papert, 1980, p. 9). Such predictions are extremely unclear as to whether schools will simply wither away or whether they will evolve by transforming themselves into something new.

I believe that economic arguments, not a major factor in education to date, will cause the above prediction to come to pass. Education is becoming big business, computer costs are rapidly dropping, and the labor-intensiveness of education is raising the costs to new heights. Only the wealthiest of nations will be able to afford a labor-intensive system of education in the future.

Summary

A brief overview of mathematics lessons on PLATO and a look at the future have been presented. Whatever happens, it is clear that educators must become extremely active and knowledgeable to be able to tame this technology and direct it in ways that are good for society. Or, to put it the way a friend of mine does, "The view changes only for the lead dog."

References

Evans, C. *The Micro Millenium.* New York: Pocket Books, 1979.

Papert, S. *Mindstorms.* New York: Basic Books, 1980.

Figure 1. Sample Titles of Mathematics Lessons From One PLATO On-Line Lesson Library.

Subject Index

1. Mathematical aspects. Calculation. Policies. Life ins.

   Mathematical logic
   see also

2. Set theory

3. Mathematical models
   Population. Growth

   Mathematical programming
   see also

4. Linear programming

   Mathematics
   see also

5. Algebra

6. Arithmetic

7. Calculators

8. Calculus

9. Combinations. Mathematics

10. Boolean algebra

11. Set theory

12. Sets. Mathematics.
    Distributive law

13. Short term financing

14. Signed numbers

15. Addition

16. Addition and multiplication

17. Addition and subtraction

18. Division

19. Multiplication

20. Subtraction

21. Signed numbers

22. Simplification. Equations

Mathematics *see also*

23. Coordinates

24. Dimensional analysis

25. Equations

26. Factors

27. Fourier series

28. Functions. Mathematics

29. Geometry

30. Graphs

31. Matrices

32. Numbers

33. Numerical Analysis

34. Numerical methods

35. Permutations

36. Probability theory

37. Ratios

38. Statistical analysis

39. Trigonometry

40. Vectors. Mathematics

41. Mathematics

42. Arrays -- for elementary students

43. Mathematics

44. Sets. Distributive law

45. --for adult basic education

46. --for chemistry

47. --games

48. MATHEMATICS, advanced. Academic Library

49. MATHEMATICS, advanced. Plato support library

50. MATHEMATICS, elementary. Academic library

51. MATHEMATICS. Basic skills library

52. MATHEMATICS. General Ed. Dev. Library

Matrices
see also

53. Simultaneous equations

54. Matrices. Fortran language. Program languages. Multiplication

*** NEXT for more ***

Figure 2. Sample Lesson Titles From Mathematics, Elementary, Academic Library.

Subject List Index

Subject:
MATHEMATICS, elementary. Academic library

1. Add and subtract with equivalence sets
by Sharon Dugdale, David Kibbey, Helen Leung, Plato Mathematics Project
FILENAME: Oslad2 LIBRARY TYPE: B1

2. Adding fractions
by Keith Bailey, Community College Math Group
FILENAME: Oaddfrac LIBRARY TYPE: B1

3. Addition and subtraction
by Sharon Dugdale, David Kibbey, Tom Layman, Plato Mathematics Project
FILENAME: Otryad LIBRARY TYPE: B1

4. Addition of signed numbers
by Tamar Weaver, Community College Math Group
FILENAME: Osignadd LIBRARY TYPE: B1

5. Addition practice, simplifying answers
by Sharon Dugdale, David Kibbey, Barry Cohen, Plato Mathematics Project
FILENAME: Opad1 LIBRARY TYPE: B1

6. Addition with equivalence sets
by Sharon Dugdale, David Kibbey, Helen Leung, PLato Mathematics Project
FILENAME: Oslad LIBRARY TYPE: B1

7. Areas and multiplication
by Esther R. Steinberg, Saul Way
FILENAME: Ozareas LIBRARY TYPE: B1

*** NEXT for more ***

Type a number for more information >>

NEXT to move SHIFT-BACK to exit

Figure 2. (Cont'd)

Subject List Index

Subject:
MATHEMATICS, elementary. Academic library

8. ASK: a twenty question type of game for guessing a number
by Esther R. Steinberg
FILENAME: 0erswk LIBRARY TYPE: B1

9. Beehive
by Sharon Dugdale, David Kibbey, Helen Leung
FILENAME: 0bees LIBRARY TYPE: B1

10. Boxes: equivalent fractions
by Sharon Dugdale, David Kibbey, Marilyn Bereiter,
PLato Mathematics Project
FILENAME: 0receqa LIBRARY TYPE: B1

11. Boxes: equivalent fractions practice
by Sharon Dugdale, David Kibbey, Marilyn Bereiter,
FILENAME: 0receqb LIBRARY TYPE: B1

12. Boxes: how much is painted?
by Sharon Dugdale, David Kibbey, Marilyn Bereiter,
Plato Mathematics Project
FILENAME: 0recask LIBRARY TYPE: B1

13. Boxes: name equivalent fractions
by Sharon Dugdale, David Kibbey, Marilyn Bereiter,
Plato Mathematics Project
FILENAME: 0recnams LIBRARY TYPE: B1

14. Candy factory
by Sharon Dugdale, David Kibbey,
FILENAME: 0candy LIBRARY TYPE: B1

*** NEXT for more ***

Type a number for more information >>

NEXT to move SHIFT-BACK to exit

Figure 2. (Cont'd)

Subject List Index

Subject:
MATHEMATICS, elementary. Academic library

15. Candy warehouse:
by Sharon Dugdale, David Kibbey, Tom Layman
FILENAME: Ocandywh LIBRARY TYPE: B1

16. Checkup: cut and paint
by Sharon Dugdale, David Kibbey, Marilyn Bereiter, Plato Mathematics Project
FILENAME: Orecchk LIBRARY TYPE: B1

17. Checkup: pizza fractions
by Sharon Dugdale, David Kibbey, Helen Leung, Plato Mathematics Project
FILENAME: Opchk LIBRARY TYPE: B1

18. Cut and paint & fraction notation
by Sharon Dugdale, David Kibbey, Marilyn Bereiter, Plato Mathematics Project
FILENAME: Orec LIBRARY TYPE: B1

19. Darts
by Sharon Dugdale, David Kibbey, Barry Cohen
Plato Mathematics Project
FILENAME: Odarts LIBRARY TYPE: B1

20. Decimal darts
by Sharon Dugdale, David Kibbey, Helen Leung, Plato Mathematics Project
FILENAME: Oddarts LIBRARY TYPE: B1

*** NEXT for more ***

Type a number for more information >>

NEXT to move SHIFT-BACK to exit

Figure 3a. Description of "Decimal Darts" Lesson.

Decimal Darts

BY: Sharon Dugdale, David Kibbey, Helen Leung,
Plato Mathematics Project
University of Illinois

COPYRIGHT DATE: 1977 FILENAME: Oddarts
LIBRARY TYPE: Academic

This learning activity is part of the fractions curriculum developed by the PLATO Mathematics Project at the University of Illinois. The exercise consists of a vertical number line with balloon illustrations placed at different locations. To burst the balloons, students must enter the decimal fraction that corresponds to the position of each balloon on the line.

(a) Further Information (b) Authors

Press the letter of the option you wish to select.
>>

LAB to try this item
SHIFT-NEXT/SHIFT-BACK to move BACK to exit

Figure 3b. Expanded Description of "Decimal Darts" Lesson

Further Information

ESTIMATED LENGTH: 30-45 minutes
100% CAI

INTENDED AUDIENCE: Elementary math students

DESCRIPTION:

This learning activity is part of the fractions curriculum developed by the Plato Mathematics Project at the University of Illinois. The exercise consists of a vertical number line with balloons placed at different locations. The distance between the numbers on the vertical line and the size of the balloons determines the complexity of the problem. To burst a balloon the student must be able to enter the decimal fraction corresponding to the position of the balloon on the line. Difficulty adjusts to the student's performance. Numbers are entered on a trial-and-error basis and the balloons may be burst in any order until there are no balloons left on the line. The exercise may be carried out with or without negative numbers.

GOAL:

Give practice locating decimal numbers on the number line.

Press NEXT to return to options

BACK-go to previous page
LAB to try this item

SHIFT-BACK go to options index

Figure 4a. Screen Display for "Decimal Darts" Lesson.
Student is to estimate location of balloons on a vertical number line.

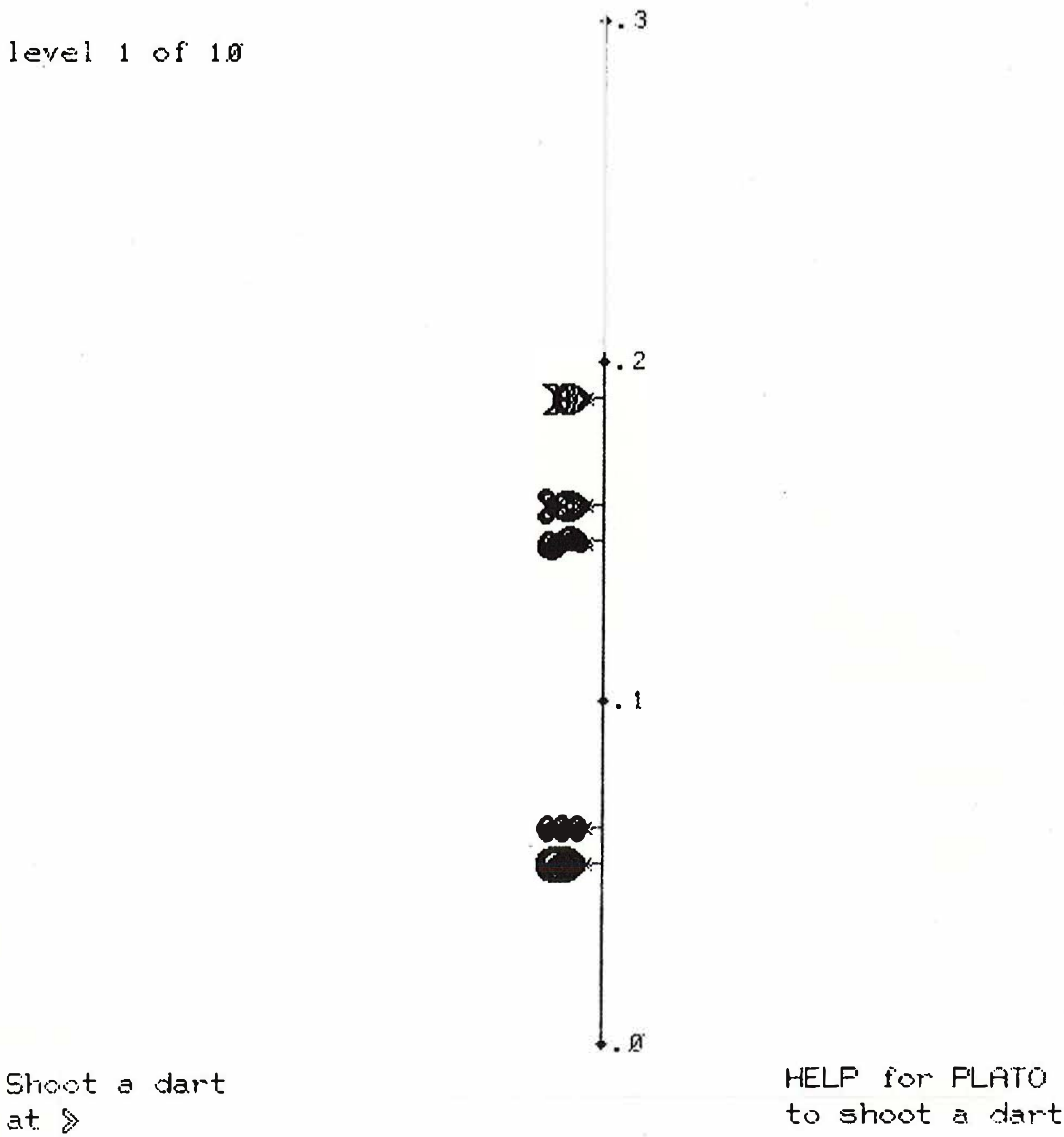

Figure 4b.
The student estimates a balloon to be located at "0.11" by typing the number at the lower left-hand corner of the screen.

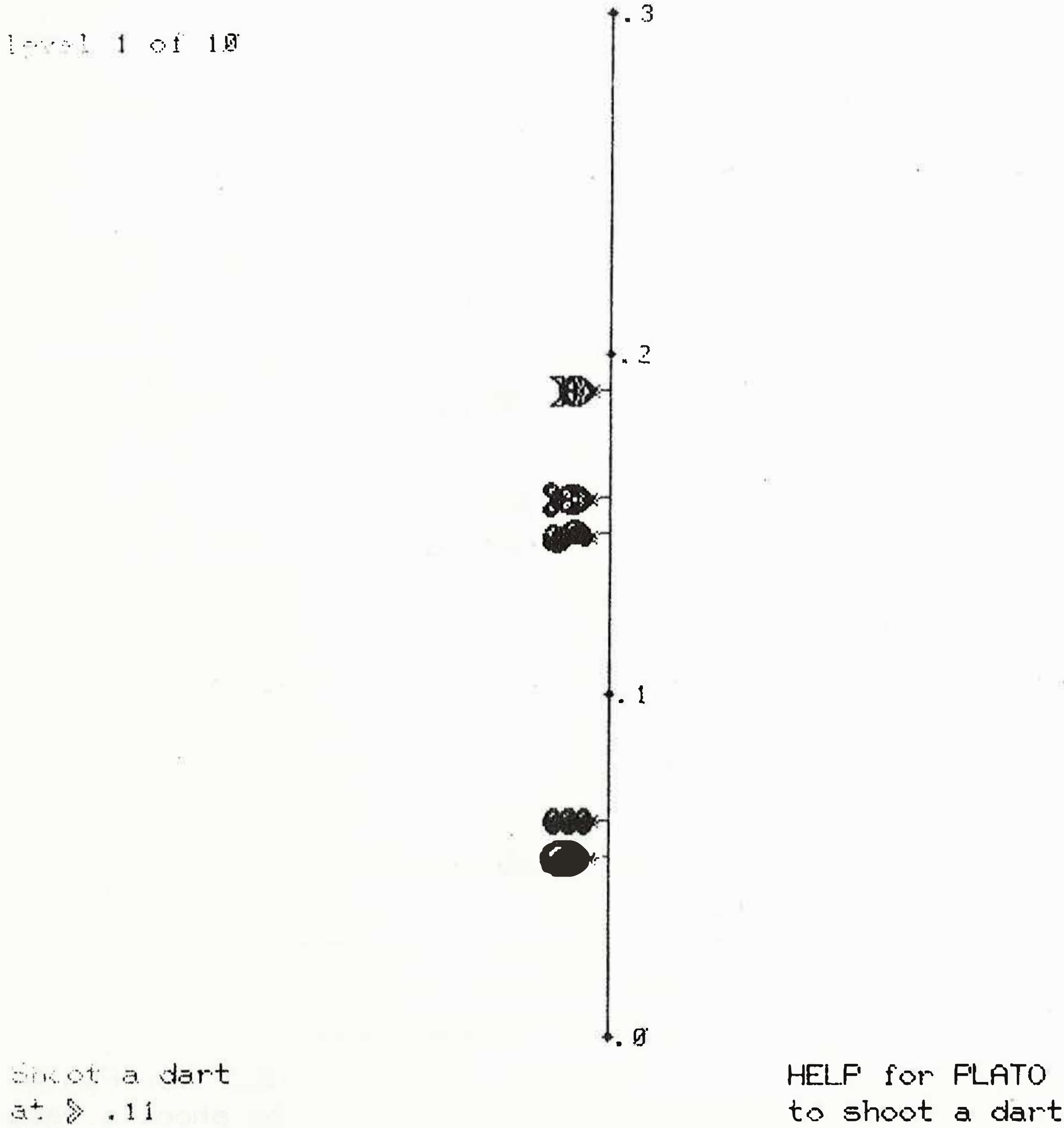

Figure 4c. PLATO Shoots a Dart at Position "0.11."
The student receives feedback on his estimate to use in refining his next estimate.

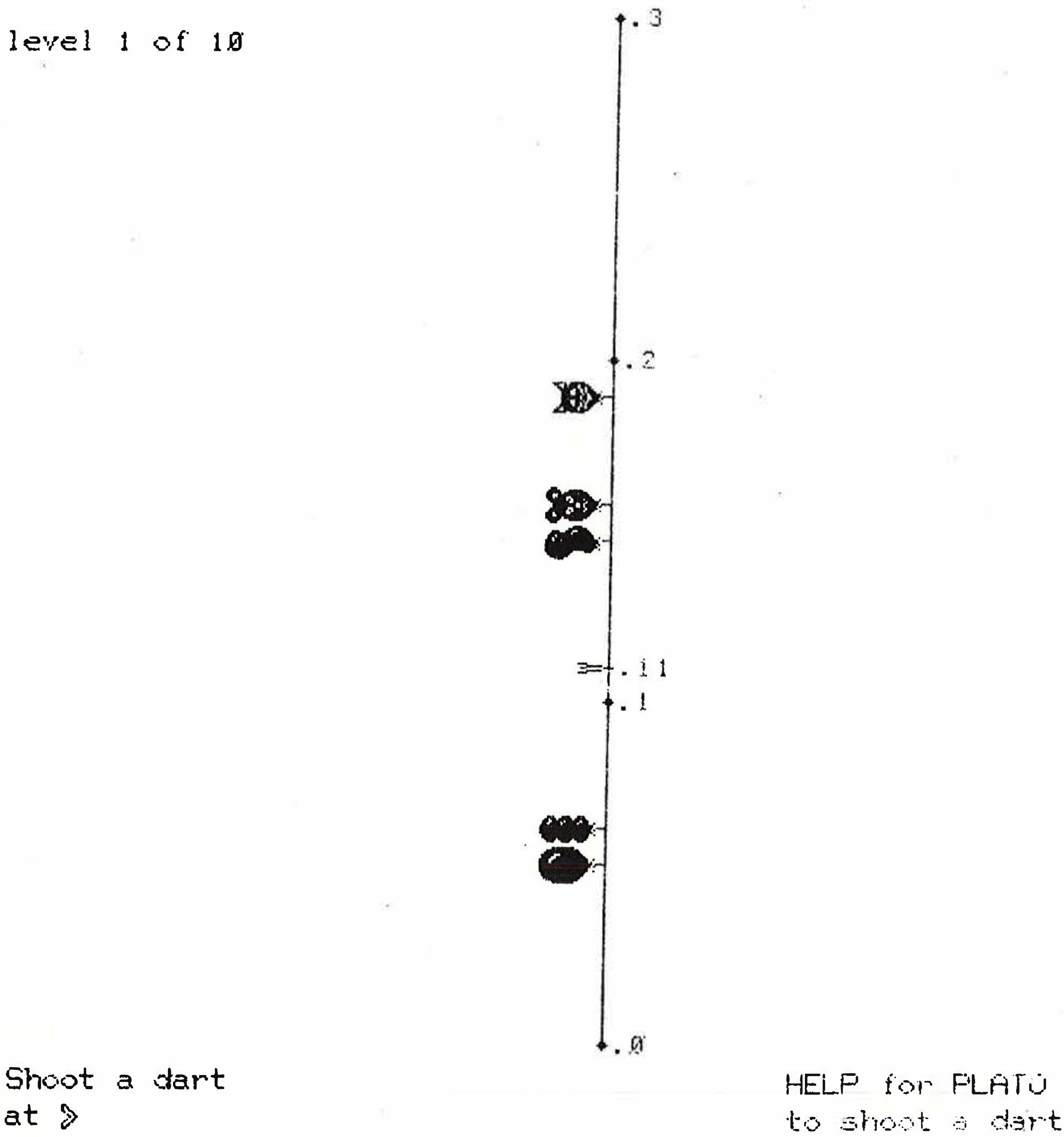

Figure 4d.
The student asks PLATO to shoot a dart by pressing the HELP key. PLATO's dart strikes at ".103."

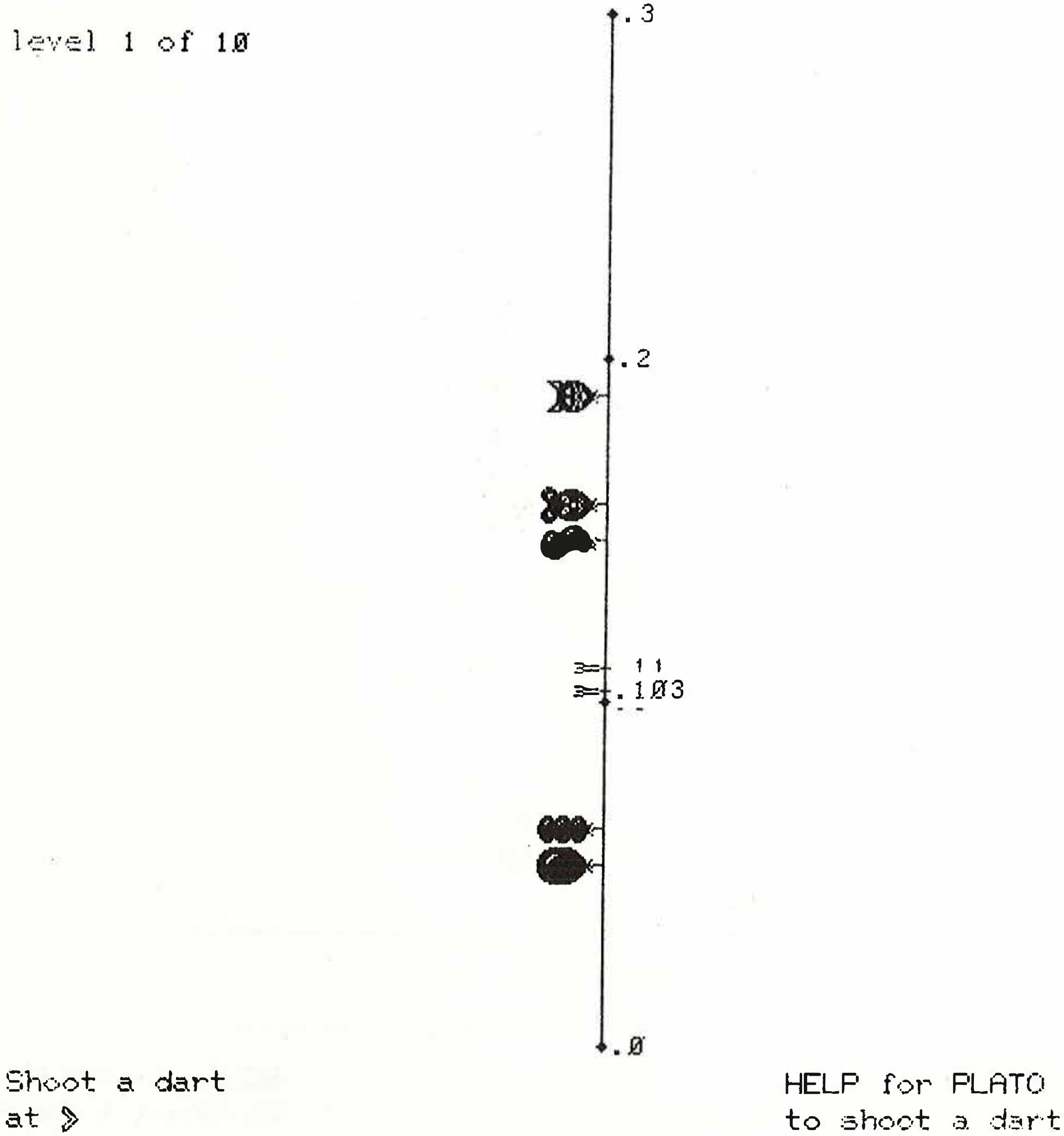

Figure 4e.
The student chooses "0.15." The balloon at that position is burst by the dart, confirming the accuracy of the choice. The total sequence will continue until all balloons are burst at which time the student can opt to have another set, change the difficulty, or proceed to a different lesson.