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COMPUTERS AND YOUNG CHILDREN

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ABSTRACT.

'Computers and Young children' is a practical approach to introducing children of 5-9 years to computers. It is divided into two parts. Part 1 'Steps Towards the Computer', is a curriculum unit to introduce children to a range of 'first computer' skills, experiences and concepts, with the view that familiarization with these activities will encourage students to approach computers and technology with confidence. It seeks to develop an interest and excitement about computers. These skills and concepts are designed to fit in with the normal work in the classroom.

Part 2, 'Beginning Logo', is designed to teach the students to feel comfortable with a computer, and to feel in control of what the computer does. The students learn the computer language Logo and learn to develop problem solving skills.

Throughout the project emphasis is placed on concrete experiences, and the children are encouraged to learn through exploration, discovery, and discussion. Creativity and imagination are also encouraged. This project does not require the students to have any previous knowledge of computers. In fact it is aimed at the student who has never had any contact with computers or the technology involved.

TABLE OF CONTENTS.

PART 1 : STEPS TOWARDS THE COMPUTER.

INTRODUCTION.

AIM.

To introduce young children to a range of concepts, skills, and experiences as a basis for future competence and success in computer work, and to make them aware of the existence of computers in their environment.

RATIONAL.

"Getting to know a domain of knowledge is much like coming into a new community of people. Sometimes one is initially overwhelmed by a bewildering array of undifferentiated faces." (1).

Entering the domain of computers is certainly like entering a new and strange community, a community filled with many powerful ideas.

Early experience with some of the basic concepts and activities in this field is a good way of getting to know it's powerful ideas and ensuring that one is not overwhelmed. Such is the reason for this curriculum project.

Computers are one of the fastest growing educational resource. Pressures from society and from within the teaching community mean that Computer Aided Instruction and computer literacy are increasingly becoming essential elements in the curriculum. Most of our students will encounter the computer at some time or other before they leave school. This may be through a computer science course, computer literacy, word processing, or simply using the computer as an aid to learning. Teachers can help their students make the greatest possible progress towards the computer world. Introducing computers, and computer-related concepts and skills to children in the junior classes is one way of aiding this process. Young children are quite capable of mastering many of the basic computer concepts, given adequate concrete experience. Children in the early elementary school years learn especially well from working with concrete objects, materials and phenomena, Giving a child a chance to manipulate, act, touch, see and feel things helps him to acquire an understanding of quite complex concepts and relationships. Piaget and Bruner both encourage 'discovery' and other intuitive approaches to teaching and learning.(2). In these approaches children acquire an understanding of concepts and principles through personal discovery. These methods have special value in teaching young children many of the concepts and skills prerequisite to computer competence. It is for this reason that this curriculum unit will begin with small, simple skills emphasising concrete learning and 'hands on' experience.

Children who get some early experience of computers in this way should be aware that it is neither too difficult nor out of reach,. Familiarity with the activities in this unit will remove invisible barriers and encourage in students an interest and desire to learn more. This approach enables students to learn these important skills, concepts and techniques at their own pace and in an environment free from the pressures they may encounter later on.

This project presents many skills useful in everyday life as well as in the classroom or in computer work. Such skills involve thinking out actions in sequence, problem solving, making clear decisions, organizing information, as well as coping with digital time, telephone and calculator keypads, and filling in forms for computer input.

This unit was designed to fit in easily with the everyday activities of the classroom, and perhaps adding a little spice and excitement to them, and creating interest and a desire to find out more. It is a simple approach to encouraging competence and confidence in the students' response to the computer revolution.

The topics explored include : Sorting and Ordering; Decision Making and Flowcharts; Dial and Digital Time; Telephone and Calculator Keypads; Visual Display; Graphics; The Keyboard; Computer Input; Processing and Computer Output; A Computer Model; and a look at The World of Computers.

CONTEXT

This unit is intended to be incorporated into the everyday activities of the Elementary classroom, and to be integrated into many subject areas, for example, art, mathematics, language, environmental studies, and others. The unit is presented in such a way as to make it easy for a teacher to select an appropriate section from the unit, and , following the guidelines in that section, to introduce the content to the students, while integrating it into the regular work in that subject area. It is also intended to be spread over at least one school year.

PERFORMANCE CRITERIA.

Many of the skills taught in this unit will require much practice and repetition before the students become confident and comfortable with them. Others will not require much effort on the part of either student or teacher, as they may already be part of the child's experience. The teacher should evaluate the childs's progress in terms of improved competence and understanding of the concepts over a long period of time. It is hoped that the student will enjoy these activities and gradually, through growing ease and familiarity, become aware that this is an area of work that is fun, enjoyable, and interesting, and that it is an area where he/she can succeed. It is also hoped that students will show interest to learn more and will be prepared in knowledge, skills and attitude to begin real computer work successfully.

PROVISION FOR APTITUDE DIFFERENCES.

The activities offer flexibility in that they can easily be extended to offer a greater challenge to the very bright student. There is scope for individual and group work to expand upon the recommended content and activities. For the slow learner, the unit can be modified in such a way as to enable this student to [illegible] his//her own pace and so achieve an adequate level c[illegible]mpetence without stress or anxiety. As most of the activities a[illegible]ractical, with emphasis on concrete experiences, it should be possible for all students to achieve an acceptable level of competence.

ENTRY CHARACTERISTICS.

This unit on first computer skills is intended for children of five years and upwards in the Elementary school, who have not yet begun working on a computer. It is suitable for students of a wide range of abilities, interests and talents. The most important prerequisite is an eagerness to explore and discover, and if these attitudes are lacking initially, it is hoped that they will be cultivated as the unit progresses. Many of the activities require a knowledge of the alphabet and the concept of number. As this unit can easily be incorporated into regular learning situations, activities requiring alphabetical, numerical and written skills can be introduced when the student has mastered these skills. More complex skills are required for some calculator work, e.g. multiplication and division. These sections should not be taught until the student has the necessary background. Some of the work with flowcharts may prove to be difficult for some children and should not be introduced until the teacher thinks the child is ready. The unit is such that sections can easily be passed over until a time when the student is in a position to tackle them successfully.

INSTRUCTION STRATEGIES.

The teaching approach most appropriate to this unit is the approach that will encourage discovery, exploration and discussion. Great emphasis is placed on the use of concrete materials, and the mode of instruction should encourage as much practical work as possible. It is necessary that students have as much 'hands on' experience as possible. A flexible teaching approach will greatly enhance this unit as many of the activities can be extended or shortened, depending on the students' interests and abilities. If the teacher or student can contribute extra ideas or activities relevant to the topic, then these too could be explored. This unit offers scope for group work, interaction and sharing among students (and teacher), so the type of instruction should facilitate and encourage this. Students should be made feel that they are actively involved in the learning process, and through their acheivements experience a sense of self-worth and success. The overall atmosphere should be positive and happy, encouraging the students to learn and grow.

SCHEDULE.

Before the unit begins the teacher must ensure that the students have grasped the skills and knowledge prerequisite to the activities. It is also wise at this time to begin collecting the materials and equipment that will be required in this unit. At this stage parent support should be elicited as parents might prove to be a good source of materials, e.g. typewriters, calculators, telephones, clocks, etc., whether on loan or as a donation. Also the parents can be involved in fostering a positive and supportive attitude in their children for the unit.

The teacher will be the judge as to the best time to begin work on this unit. The knowledge that the teacher has of the abilities, interests, and progress of the children in the class will determine the depth and extent to which the unit is explored, and the pace at which the students progress through the unit.

Many opportunities will arise where reference to, and revision of, materials in the unit can be taken advantage of. It is through constant practice of the skills and concepts that the students will become competent and skillful. In this way too, the unit will not be seen as a set of activities and skills isolated from the other work in the classroom, but rather as a normal and ongoing part of the curriculum. The students should then be prepared to move easily and without anxiety into a program to introduce them to work on a real computer.

LOGISTICS.

Equipment:

A collection of clocks and watches; dial, digital, and 24 hour.

Telephones: one with a dial, one with a keypad.

Calculators: of varied sizes - if possible, a suitable number would be one between every two students.

Typewriters - to teach the keyboard, typing small words and messages, etc. May be either mechanical or electric. They need not be modern as old-fashioned ones are also useful.

A computer and a video display terminal - needed for keyboard practice, examining both text and graphic output displays.

Most of the equipment, except the computer and display terminal could perhaps be borrowed from friends, parents; or perhaps the school secretary.

Materials:

An adequate supply of materials for sorting and classifying according to colour, shape, size and height.

Number lines, number stairs, other materials for number work.

A large classroom alphabet and other materials suitable for alphabetical order work.

Pictorial stories that can be arranged in order of sequence of events.

A supply of timetables showing the times according to the 24 hour clock.

Pictures of different keypads, e.g. automatic bank tellers.

Pegboards and elastic bands.

Squared paper of different sizes.

Examples of computer printout, text and graphic.

Examples of bar codes.

Pictures of, or if possible, real examples of computer input and output devices, e.g. disks, disk drives, tape recorder, printer..

Pictures and examples of computers in the workplace, in banks etc., and pictures of people using them.

FACILITIES.

The students' regular classroom is the most suitable. The unit should be supplemented with some outings to see computers in the local environment.

PERSONNEL.

This unit could be taught by any Elementary school teacher experienced in working with young children and having an understanding of the cognitive levels of this age group. It is recommended that the teacher be the normal classroom teacher of the children. The teacher should have an interest in computers and an interest in encouraging children to be prepared for formal computer work. It would be an advantage if the teacher were computer literate, but a deficiency in this area could easily be compensated for by good preparation and a willingness to learn and explore with the children. The teacher should be well organized and prepared for the unit and approach it with a sense of enthusiasm and excitement.

TIME.

The length of time required for this unit will vary depending on the age and ability of the class. However it is recommended that the unit be spread over at least one acedemic year in order to give the children adequate time to gain practice and familiarity with the skills and concepts. The amount of time per day or week devoted to the activities will depend on the depth to which the unit is being explored, the interest the students show in it, and how it relates to other classroom activities at that time. It is recommended that students be given sufficient time to explore, discuss and compare their ideas and interests with fellow students and the teacher. The teacher must keep in mind that opportunities for revision of skills and concepts should be availed of. Adequate teacher preparation time is also an important factor for the success of the project.

PROGRAM EVALUATION.

a) Effectiveness:

The program could be regarded as effective if

- the students are interested in the activities and enjoy them;
- over a period of time all students understand the concepts presented and master the skills they have been taught;

- the students can approach computer work eagerly and confidently;
- the students are aware of computers in their environment and seek to learn more for themselves.

b) Acceptability.

The course could be regarded as acceptable if:
- the teacher involved believed that it was a valuable learning experience for the students;
- the students developed positive attitudes towards computers and computer-related activities;
- the parents, teacher and principal felt that it was a worthwhile unit and that it provided a stepping-stone to many important learning situations.

IMPLEMENTATION.

The classroom teacher is the main factor in the imlementation of this curriculum unit. This teacher would have to be eager and interested in implementing it, and see its potential value to the students. Parents' and principal's support would also be an advantage. This would perhaps be forthcoming in view of the demand for computer literacy and the growth of computers in education.

REFERENCES.

(1) Papert S., 'Mindstorms: Children, Computers and Powerful

Ideas.'

(Basic Books Inc. 1980) p. 137.

(2) Gage and Berliner 'Educational Psychology'

(Houghton Mifflin Co./Boston,1978).

1. SORTING AND ORDERING.

Information for a computer must always be accurate and must be entered in logical order. To develop competence in arranging material in order or sequence, activities to foster understanding and skills in sorting, ordering, making lists, and working in alphabetical order become important. Sorting is an important mental activity which consists of observing a common attribute of certain members in a collection and in grouping together those objects which have the common attribute. Young children usually begin to sort according to colour and this can readily be extended to include other physical attributes. Ordering is a thinking strategy which develops in children along with the ability to sort and classify. In ordering, the child first has to find a common characteristic and then order the objects in the set according to the magnitude of that characteristic in each object.

The following activities begin with objects and people in the child's immediate environment and progress to levels where understanding and knowledge of number (0-20) and letters of the alphabet are necessary.

1. Sorting and Ordering.

(a) Vocabulary

behind beside

big bigger biggest

short shorter shortest

long longer longest

small smaller smallest

tall taller tallest .

the same as

colour words.

Develop the vocabulary by using familiar objects and take advantage of sets that crop up in the classroom.

(b) Sort and classify collections of assorted objects according to colour, size, length, shape.. Emphasise positional vocabulary, colour words etc, according to the maturity of the group.

(c) Ordering collections of objects according to length, size, weight and capacity. Activities could take the form of -

i) copying patterns of shapes in a particular order.

ii) arranging objects in order of size - from largest to smallest, from smallest to largest.

iii) arranging collections in ascending or descending order of size, etc.

iv) grading childrens' foot-length, lengths of string, wool, rope..

v) arranging children in class in order of height, from smallest to tallest, and vice versa.

2. Ordering of Numbers.

Vocabulary:

before after

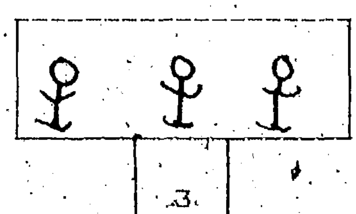
more than less than.

a) Activities to teach that numbers follow each other in sequence. Through experimenting with sets of objects they will learn that one object added to the set will give the next number on the number line. By using the number line and the number ladder they will learn that each number in the sequence is one more than the preceeding number and one less than the next number. For example:

1	2	3	4	5

Three is one GREATER THAN two and one LESS THAN four.

(b) Use of materials and activities (e.g. Unifix cubes) to build number lines and stairs to reinforce the concept of the number of units represented behind the symbols. Making collections of objects, counting them and assigning the correct numeral. For example:



Various activities to encourage counting in sequence - number of boys and girls in the class, number of fingers on each hand.

3. Making Ordered Lists.

a) Children have to put many sets of things in special order.

For example, in getting ready for school, putting on a teeshirt must come before putting on a coat. Constructing a list of the best order for such everyday activities is a valuable exercise.

b) Allow children t work out a set of instructions to perform a simple activity, e.g. painting a picture. They must make decisions about the sequence of these instructions. These instructions are given one at a time to a pupil who will carry them out. Any gaps or faults in the pattern of instructions will be evident.

c) Making complete lists and putting them in the right order for a wide variety of familiar activities.

d) Telling a story by putting events in the correct order:
(i) This is best begun by using pictures, making decisions about the right sequence and then telling the story.
(ii) Allow children to cut pictures from magazines and arrange them in order as they compose a story.
(iv) Have the children create a mural showing all the important things they can do during the day. Because the pictures must be in the order in which events occur, the first picture should probably show a child getting up in the morning.
(iv) Sentences not arranged in order must be read and then put in sequence. The pupil then reads the complete story.

Bedtime.

Paul goes to sleep.

- Paul puts on his pyjamas.

It is time for bed.

He gets into bed.

Mummy reads him a story.

4. The Alphabet.

The following activities require a knowledge of all the letters of the alphabet. A large wallchart showing all the letters in alphabetical order is also necessary.

a) Word Collections.

As the children encounter new or difficult words they can be grouped according to the initial letter and displayed on word charts around the room.

b) Names in Alphabetical Order.

This activity should begin with familiar names, for example a list of the family members in alphabetical order, friends names, class list, teachers names, etc. Many of these lists can be compiled according to first names or family names.

c) Examination of published materials whose content is arranged alphabetically, e.g. telephone book or dictionary.

Discusion of questions such as: "Why are they arranged in this way?"; "How does this help us?"

d) Alphabet Games.

For those children who have mastered the previous activities, the following games will further reinforce the idea of alphabetical order.

(i) Counting along the alphabet - which is the tenth letter?

(ii) Animal alphabets - A for alligator, B for bull, C for cat.... Many games could be constructed in this way using diferent groups of objects - objects at home, food and drink. These could be arranged into a pictorial or illustrated alphabet.

(iii) Alphabetical anagrams. This game involves a student selecting a word well known to the others and rearranging the letters in alphabetical order - e.g. abll or aeehlnpt, and presenting it in this form for the others to solve.

(iv) "I packed my suitcase" game.

Each student adds an item to the list of objects. Variations:

- alphabetical list of objects;
- or each object to have an adjective (also alphabetical if you want): a blue bag, a crimson coat, a dirty dog).

"I went to the Zoo and I saw....

"I went to a restaurant and I ate....

"I went to the store and I bought....

Activities like these are suitable for most levels and are good for vocabulary as well as for ordering alphabetically.

2. DECISION MAKING and FLOWCHARTS.

This chapter is an extension of the sorting and ordering activities and concepts of the previous chapter, which are fundamental steps in the decision making process. As the computer is a machine, all the information and instructions to be given must be arranged in advance in completely accurate and unambiguous order. Flowcharts are a good way for children to illustrate in a clear and specific way the order of instructions and decisions for the computer.

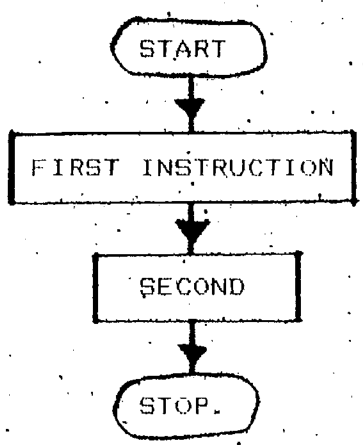
a) A simple beginning would be to present the student with a set of pictures depicting actions for a particular activity e.g. 'getting ready for school', and requiring him/her to put them in the correct sequence. See Activity 1.

Vocabulary: START THEN STOP

b) Simplest Flowcharts.

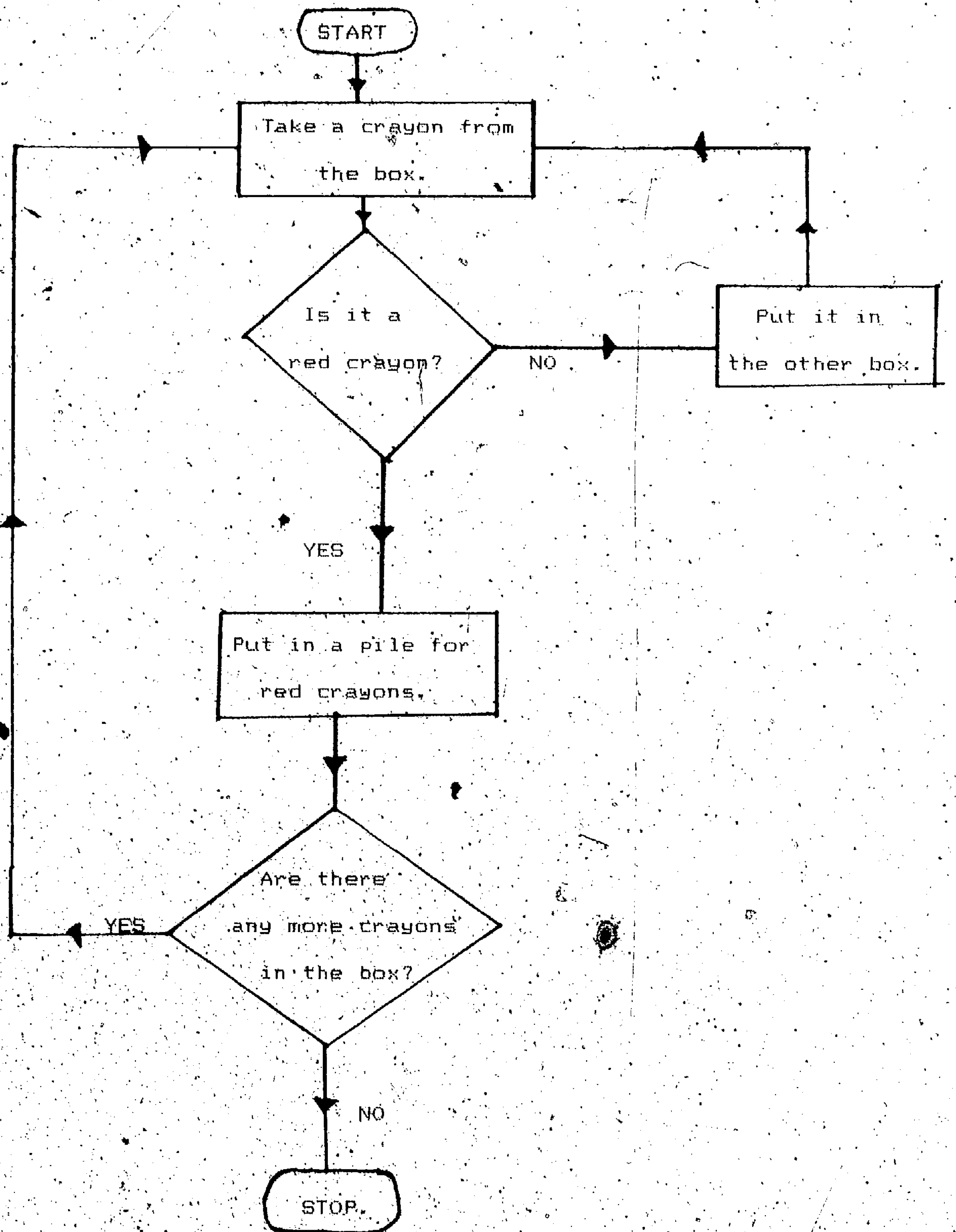
- A Flowchart always begins with a standard word, such as START, or ENTER.
- There must be a signal to end, such as STOP, or EXIT, or END.
- These signal words are written inside a horizontal shaped 'racetrack' outline. START STOP
- From the centre of the START outline an arrow points downwards to the first instruction, in a rectangular outline.
- In the simplest flowcharts the pattern is very simple,

consisting only of things to do. For example:



c) In many cases questions must be answered before the next step or instruction can be given. Such questions are enclosed in diamond shapes, 'decision diamonds'. From this shape there are two arrows, one indicating YES and the other NO. The students must be made aware that YES and NO are the only possible answers in any flowchart for a computer because of the way in which the computer functions. The arrows from a decision diamond will create loops, but they must always return to the main stem of the program.

A Simple Flowchart for Finding Red Crayons.



All students should be given an opportunity to develop their skills in making simple flowcharts. Individual students can compete with each other to make the most interesting flowchart, and also to make the most efficient one. Many of their first attempts may contain mistakes or ambiguities and they may be of great help to each other in spotting these slips and offering suggestions on how best to correct or improve them. Many everyday materials can be used as subjects for a sorting process in a flowchart. See Activities 2 and 3.

d) Making Decisions.

Computers can only work on a yes-or -no basis, and for computer work children must learn to ask questions where only a yes/no answer is possible. Games like Twenty Questions, "Animal, vegetable or mineral?", played with strict attention to the rules, give the students good preparation for computer programming. This process of questioning seeks to establish or eliminate classes of things first, e.g. "Is it a person?", with the whole point of the activity being that the answer is either yes or no. Such activities are good for stimulating concentration, observation, and logical thinking, as well as being good computer practice.

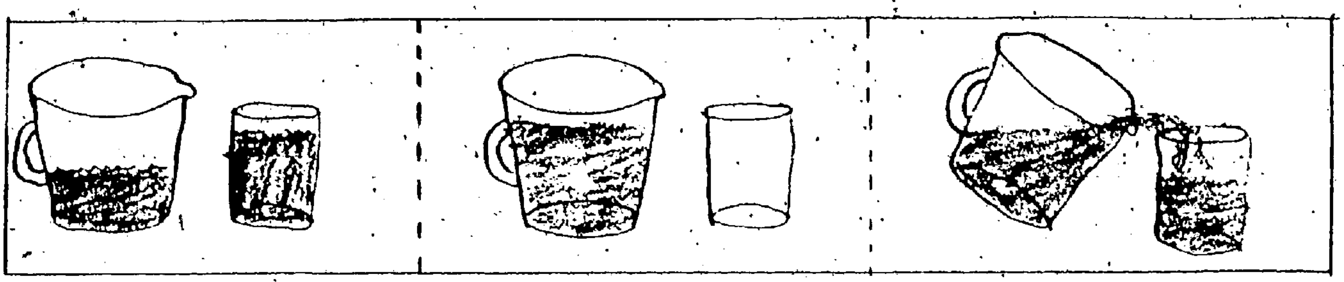
ACTIVITY 1.

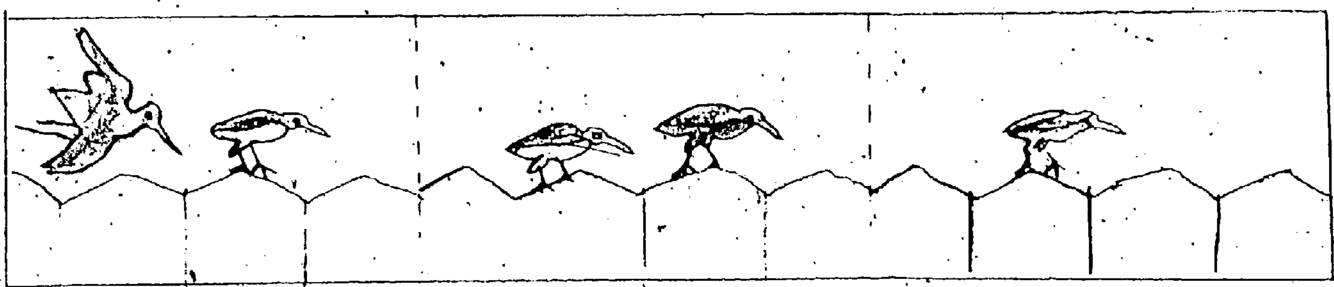
Objective: To give students experience in ordering sets of pictures.

Directions:

1. Give a copy of the set of pictures tb each child. Provide scissors for students' use.
2. Go over the directions carefully; be sure students understand what to do and that each row of pictures is a seperate set.
3. After each set of pictures has been put in order, discuss reasons for the set's order, using the key vocabulary words.
4. Provide strong paper and glue. Have students glue their sets of pictures in order on the paper. Display the mounted sets.

Activity I.





4	1	5	2	3

ACTIVITY 2.

Objective: To provide students with experience in putting the steps of a procedure in order on a flowchart.

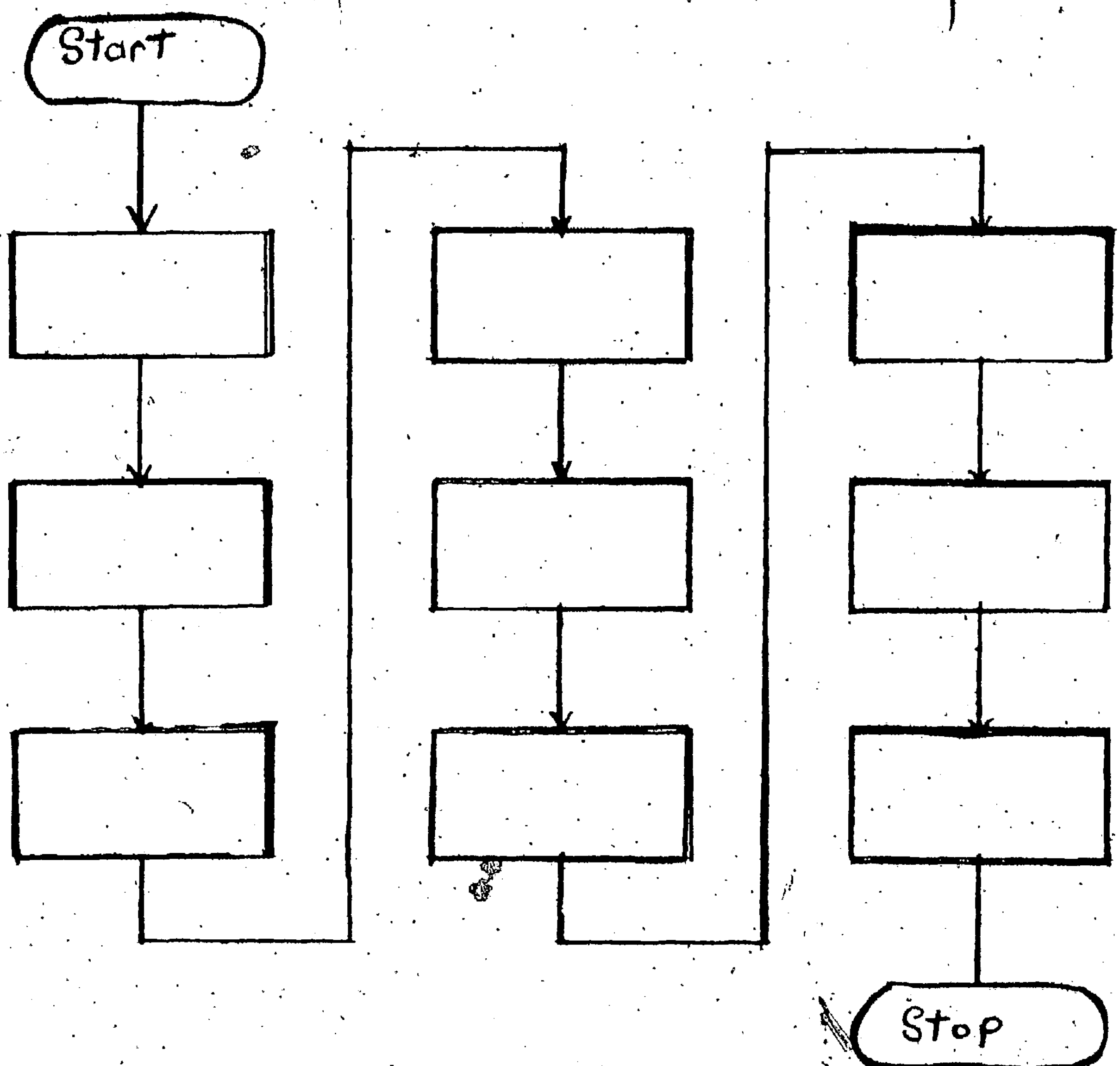
Directions:

1. Provide each student with a copy of the worksheet, scissors and paste.
2. Be sure students understand the directions.
3. Check students' work before the rectangles are affixed to the flowchart.

Some Further Activities:

1. Have students make a flowchart to show the steps involved in making a telephone call.
2. Have students make a flowchart to show the steps involved in getting out of bed and dressing in the morning.

Activity 2



Walk to Mailbox	Write Address on Envelope	Put Letter in Envelope
Get Paper, Envelope and Pen	Stop at Mailbox	Put Postage Stamp on Envelope
Seal Envelope	Put Letter in Mailbox	Write a Letter.

Cut out each direction. Put the directions in proper order, then place them in the rectangles in the flowchart.

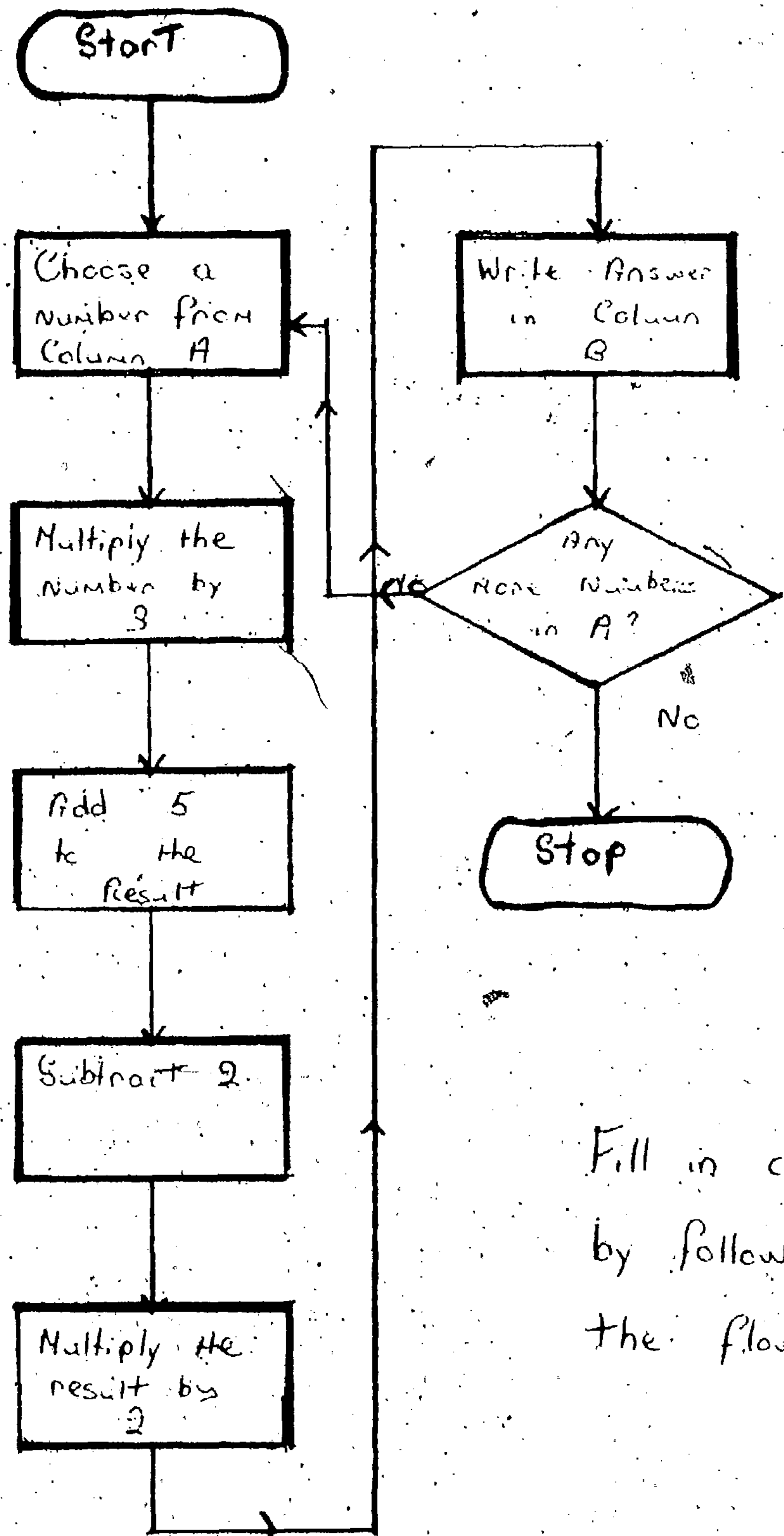
ACTIVITY 3.

Objective: To give students experience in using a flowchart.

Directions:

1. Provide a copy of the worksheet for each student.
2. Go through the flowchart with the children to insure understanding of the procedure. The first answer has been entered on the worksheet.
3. Students may use a calculator if they have already learned how to operate one.

Activity: 3



A	B
2	18
1	
6	
5	
70	
130	

Fill in column B on the table by following the steps on the flowchart.

3. TELLING THE TIME: DIAL and DIGITAL TIME.

Telling time is one of the most difficult measurement skills for children to learn, yet can be one of the most enjoyable and rewarding topics to teach. Dealing with time is one of the most important and useful survival skills for children as well as for adults. Most children are introduced to the concept of time via the traditional dial clock, and read the time from the position of the hands. But increasingly, the child encounters digital clocks and watches in his/her environment. One of the most obvious things about most modern clocks and watches is that they tell the time in numbers. Also, timetables, T.V. and radio programmes give the times of programmes in figures. Children have to learn to connect the two ways of telling the time and should be able to relate one method to the other.

(a) The Traditional Clock.

The standard dial clock is an essential item in any junior classroom. The children learn and become familiar with important times of the day mainly by recognition of the visual pattern made by the hands on the clock dial. To get beyond this stage the children need to comprehend that the time around the dial is measured in countable minutes, and that the figures stand for minutes as well as hours.

Consider the following procedure to introduce students to telling the time:

– Prepare a classroom set of clock faces that have only an hour hand and pass them out to the class. Explain to the children how the day is seperated into two parts of twelve hours each, and that the hour hand in the clock tells us the particular hour of the day. No other hand is really needed. Begin a demonstration showing two o'clock, and so on, making certain that each child is responding correctly.

– The next step might be initiated by asking a question; "How could I show the time if it was a little past four o'clock, but not yet five o'clock?" Encourage students to respond that the hour hand would need to point somewhere between the numeral 4 and the numeral 5.

– Through discussion, examination of their clock faces, and practice in moving the hour hand, students could be helped to make more and more precise judgements as to the exact time. For example, the clock face pictured in Figure 1 could be discussed as showing "half-past nine o'clock" since the hour hand is approximately halfway between the numerals 9 and 10.

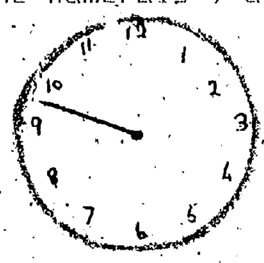


Figure 1

– Continue in this way with the students until such time as a 'quarter past' the hour becomes familiar to each child. At this point, instruction on the function of the minute hand may begin.

- Discuss with the students how they have been able to tell the time with a fair degree of accuracy by estimating the distance the hour hand is from one numeral to another. Then explain that timekeepers have found a way to be even more precise - they have divided each hour into sixty parts, called 'minutes', and have added another hand to the clock.

- Pass out a new set of clock faces, so that each child has a face with the 'new hand' on it. Compare the two hands; observe how they are different. Then explain that every time the hour hand goes from one numeral to the next, the new hand goes completely around the face of the clock. It starts at 12 and goes around to 12 by the time the hour hand has made its journey from one numeral to the next

- Have every student put the new hand on the starting point and the hour hand at nine o'clock. Show them how the new hand actually travels halfway around the clock while the hour hand moves to the now familiar midway position between 9 and 10.

- Help the children count the intervals on the clock face to show them that the new hand has actually gone 30 spaces, and that each space is equal to one minute.

- Through discussion and examples, make further generalizations to such concepts as 'quarter past nine', and so on.

- Finally, ask students if they can show eight minutes (spaces) past three o'clock and so on. Initially this should be done by counting. As they gain confidence and experience they can use the shortcut of counting each numeral as five minutes.

- Revise the whole process by asking the students to tell the approximate time as you maipulate the clock.

(b) A Clock Project.

Students are required to make lists and illustrations of clocks they see in the environment, and tell what time the clocks show. This activity is bound to reveal digital clocks and provides the opportunity to explore this type of time piece.

(c) Make a Model Digital Clock.

This can easily be made from a horizontal rod, four large loose-leaf file rings, and two sets of numbers, perhaps cut from an old calendar: One set, from 1 to 12 (initially) for the hours can be hung on two rings on the left. The other set from 00 to 59, would hang from the second set of rings on the right hand side. A dial clock beside this model makes it simple to correlate the two methods of telling the time. By colour-coding the hours of the digital clock with the hour hand on the dial clock, and likewise the minutes on the digital clock with the minute hand, a further simplification of the time telling process is possible.

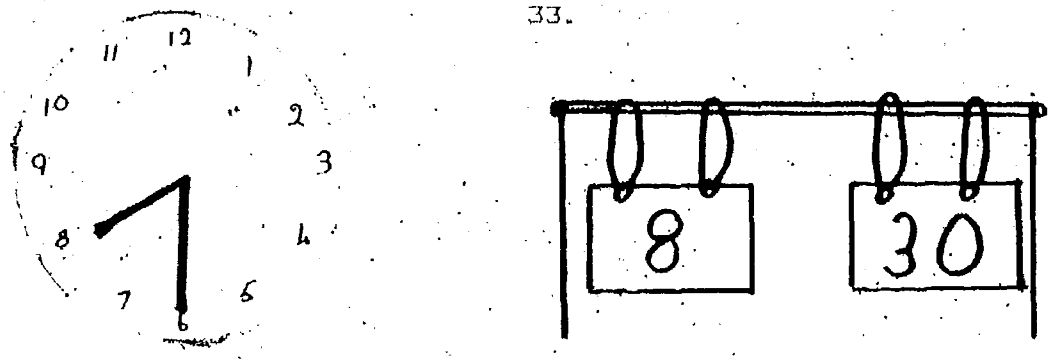


Figure 2

Various activities can be devised whereby the children read the time from the real dial clock and convert it to digital time on the model clock, e.g. lunch time, 12 o'clock will be recorded as 12.00 on the digital clock. This may pose problems for some children who will ask; "Why zero zero and not sixty?" It will have to be explained that zero zero and not sixty is the end of a complete circuit for the minute hand on the dial clock.

(d) The 24-Hour Clock.

Previously, time had been taught with the concept that the day was divided up into two 12-hour parts. At this stage the idea of a complete unit of day-plus-night and the 24-hour clock can be introduced. Instead of beginning another time unit at 12.59 we can continue to 13.00 etc. up to 23.59, before we begin the next 24-hour unit. The teacher should provide a model or a real clock face with the second circle of numerals, in order to reinforce the 24-hour concept. Pupils should be encouraged to think about the times in the afternoon in terms of the 24-hour system. Many activities can be constructed around this concept to ensure that students understand and can use this system properly. For example, holiday brochures, train and airport timetables can lead to many exercises whereby the students interpret the times from the 24-hour system, calculate the departure/arrival times, length of journey, etc.

Converting the digital model clock to the 24-hour system is very easy - simply include the numbers 13 through to 23 and zero in the left hand set of numbers. Many of the previous activities can be adapted to this new system, and children should be given plenty of opportunities to convert from the 12 and 24-hour system on a dial clock to the 24-hour digital clock.

4. KEYPADS : (1) TELEPHONES.

(a) Begin this section by looking at the dial on an ordinary telephone. "In what order are the numerals". "What is the first number?". "What is the last number?", etc. The students will notice that telephone numerals start at 1 and add the zero at the very end.

- Children can draw the layout of the the telephone dial and point to the numbers required to dial their own phone number, or that of a friend. They should be given practice dialing numbers on the telephone.

(b) The Telephone Keypad.

Many new telephones have press-button keypads instead of the dial.

- Children should be given the opportunity to use a telephone keypad. "Is this way of using the telephone easier than the dial method?". "Why?", etc. Idea to be reinforced : Pressing keys is a way of telling the telephone what number to connect you with.
- Exploration of the layout of the numerals:

"What number comes first?" "What is the last number?" "What position is the zero?"

1	2	3
4	5	6
7	8	9
	Ø	

- Children should draw diagrams of the keypad and fill in the correct numbers. An additional activity at this stage would be to add up the numerals down the middle, and diagonally in both directions.

- Children can practice putting their fingers on the correct keys in the correct order for their own home telephone numbers, or any other phone numbers they know.

- When children have a grasp of the position of the numerals, the following activity can serve to reinforce the concept: A child can be given an empty 9-square grid, with the extra square at the bottom, and then be asked to put in a given numeral as quickly as possible, until the grid is completed. (Students can refer to a diagram or a real keypad to make certain of the positions.)

- A collection of both real telephones with keypads and illustrations of this type of telephone can be made. Discussion may follow about which size, shape, or style is better and the reasons for this.

- Children are to be encouraged to look for keypads with exactly the same layout as that of the telephone in the environment; to find out their function and report back to the class with their findings, e.g. automatic bank tellers.

KEYPADS : (2) CALCULATORS.

(a) In their search for keypads the children are bound to encounter calculators. But close examination will show that in fact the number pad is arranaged differently, and also that other keys are present which do not appear on a telephone keypad. Similarities exist in that pressing keys can give the calculator figures to work with, while the other keys can tell the calculator what to do with these numbers. It is important that the children become familiar with calculators and learn to use them intelligently.

- Every child should have access to a calculator for these activities. An ideal situation would be to have one calculator between every two or three children.
- Begin the study of calculators by allowing each student to handle a calculator and to press various keys and watch the display.

The arrangement of numerals on the calculator may be confusing for the children as the arrangement is diferent from the telephone keypad which they have just learned. On calculators, and on the keyboard of many computers, the top line goes 7,8,9, with 1,2,3 along the bottom, and the 0 below this. The decimal point is usually beside the zero, but until the students know about decimal points, this one can wait.

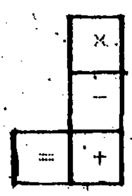
- The best way to become familiar with the calculator keypad pattern is to draw it (numbers only) on paper and practice pressing the numbers.

7	8	9
4	5	6
1	2	3
0		

- Activities similar to those used for the telephone keypad can be used to get the children familiar with the arrangement. If the child adds the figures up, and across the middle, the totals come out the same, and they are the same as the totals on the telephone keypad. Activities like the those in Table 1 help children to learn the key pattern by requiring them to fill in the correct number to complete the sentence. Other numbers they could 'key' in are house number, day in the month, number of people in family, etc.

- The Operations Keys: these tell the calculator what to do with the numbers you give it. The use of these keys will depend entirely on the stage the children have reached in their own number work. Children will learn to identify and name each key and (depending on their level) to understand their functions.

The = sign (which may not appear on all calculators) should be called whatever it is called in the everyday mathematics activities of the class. The best way to recognise the location of these keys is, once again, to draw a diagram.



- The ON/OFF switch: Children will learn to switch on the calculator when beginning to use it, and switch it off when finished.

- Children can be presented with a calculator without the batteries in it. When they switch it on and press some keys they should notice that there is no visual display, nothing has happened. If one of them knows, or can see how to open the calculator case, they will discover that the battery is missing. A child will be given the task of replacing the battery into its proper place, checking to see that it is the right way round. Now, when turned on the calculator will work. Children should be aware of the concept that a calculator needs a battery to work. They should be given practice in putting in the batteries and switching the calculator on. Another point to emphasise is that the batteries can be used up or 'run out', and therefore the calculator must be switched off when not in use.

(b) Using The Calculator.

Some Vocabulary

Input: ON, the numbers we key in, the five mathematical symbols (or operation keys), CLEAR, and OFF.

Output: results shown in the Visual Display window.

There has been much debate about the use of calculators in the classroom. Teachers are concerned about how calculators will affect students' computational skills (Palmer 1978). The calculator will not replace these computational skills, and students who are working on their basic computational skills should be encouraged to use a calculator to check their answers. Through guided activities in the classroom, the calculator can be a very valuable teaching tool in exploring a variety of mathematical topics. In a survey by N. Lakariya (1980), problems which the vast majority of the class had been unable to solve without a calculator were manageable for all when they used a calculator. The calculator makes it possible for students to concentrate on analyzing how to solve a problem as they are relieved of the cumbersome computation in arriving at the solution. The literature also suggests that the calculator is a source of motivation (Lakariya). Whatever the teachers' feelings about the calculator, one fact that cannot be disputed is that the calculator is here to stay. The best way is to see how to make use of calculators, in ways that strengthen the pupils' knowledge of the required number work at the same time as their ability to use these modern aids. Calculators can be seen as 'little computers', and familiarization and ease of use will certainly prepare the student for future computer work. Knowledge of calculators will also make them aware that they can face and master other technical gadgets, e.g. programmable radios, video recorders, or microwave ovens. They will grow in confidence in learning how to conquer new technology.

The best way to become familiar with a calculator is of course to use it. The activities at the end of this chapter, and others of a similiar kind are useful in fostering competence in the children.

An important point to be grasped is that the 'instructions' have to be given in a very exact and specific form to the calculator. Some calculators use algebraic logic, i.e., the order in which the numerals and the symbols for the processes (+, -, etc.) are pressed is the same as the order in which we usually say them for mathematical purposes - e.g. three plus (add, and) two, or eight minus (take away, subtract) four. Children should be encouraged to get into the habit of saying what they are doing in this standard way, because this is the way the calculator is built to work.

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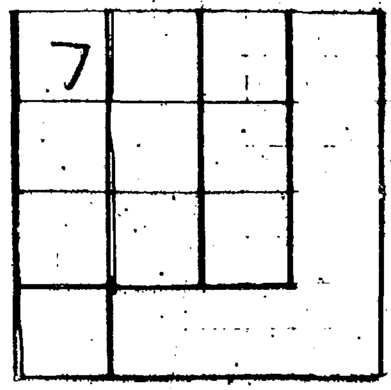
I am



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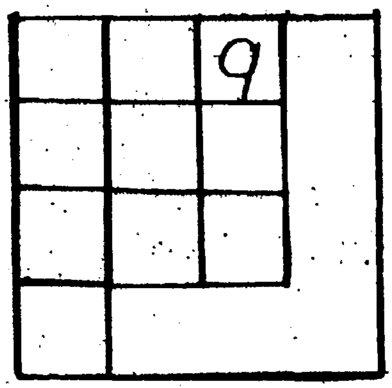
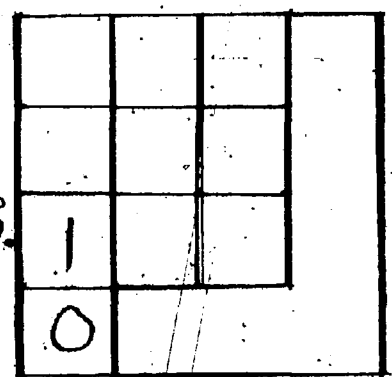


boys

and

girls in my class.



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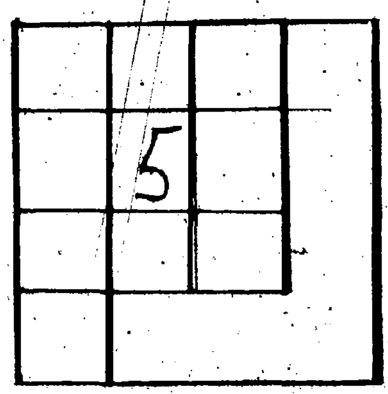


books

CALCULATOR ACTIVITIES.

* * * * * * * * * * * * * * * * * * *

1. WHICH TARGET WILL YOU HIT?

Objective:

To allow the students to get experience in using the calculator correctly, and to give them some practice in problem solving.

Directions:

1. Provide each student with a worksheet and a calculator.
2. Instruct the students to look at the problem carefully, then to look at the target numbers. One of the targets is the correct answer - which one? Students record their guess and then key the problem into the calculator to check the answer. If the student guessed correctly then he/she is awarded a point. The total number of points is recorded at the end.

Which target will you hit?

1. Look at each problem.
2. Look at the targets
3. Guess which target is correct and record your guess
4. Use your calculator to check
5. Give yourself one point for every correct target you hit.

	Which target		Guess	Check
4 + 2	7	6	___	___
7 + 4	11	10	___	___
8 + 6	14	15	___	___
5 + 3	9	8	___	___
8 − 4	4	5	___	___
7 − 6	1	2	___	___
9 − 2	7	11	___	___
3 − 1	4	2	___	___
4 + 3	1	7	___	___

Write what your

shows

Total ______

2. ADDITION GAME.

Objective :

Experience in addition, in using a calculator and practice in estimation.

* * * * * * * * * * * * * * * * *

3. ADD OR SUBTRACT GAME.

Objective :

Experience in estimating sums and differences, and practice in using a calculator.

Directions for Games 2 and 3:

1. Group the students into teams, with two teams sharing a worksheet and a calculator.
2. Each team finds its answer on the game board and puts the team's mark on it (X or O). The game is won when a team has an un-broken path of marked answers that connects the two sides on the game board.
4. Play the game more than once. At first students may pick pairs of numbers at random, but as they play more often they will start to develop strategies for using their estimation skills to select the numbers.

An interesting modification of the game is to require one player to pick the first number and another player on the same team to pick the second number.

Addition Game (2 teams)

1. Teams take turns. Pick any of these numbers

1 3 5 7 9 20
2 4 6 8 10

2. Add the numbers you picked

3. If the answer is on the game board, mark it with an X or O.

Game Board

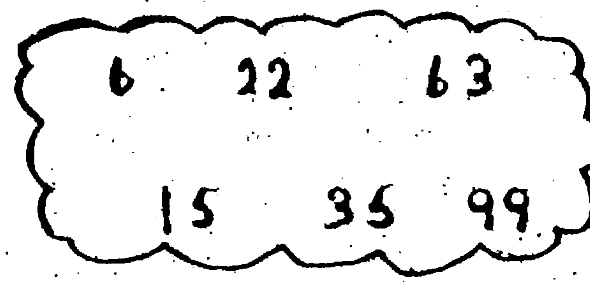
11				
18	28			
6	14	7		
16	30	23	25	
9	5	27	13	17
26	8	19	10	
12	24	21		
22	29			
16				

How to win:

The first team to get a path of answers (three or more) connecting its two sides of the game board wins.

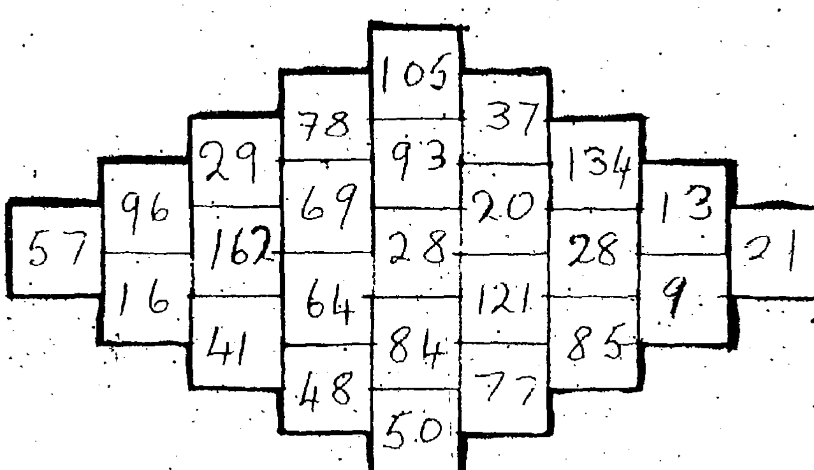
Add or Subtract Game (2 teams)

1. Teams take turns. Pick any two of these numbers



2. Add or subtract the numbers you have picked.

3. If the answer is on the game board, place your team's mark on it. (X or O)



How to win.

The first team to get a path across the game board wins

CALCULATOR ACTIVITIY No. 4: TASK CARDS.

Objective :

To help the students become familiar with performing successive operations on the calculator.

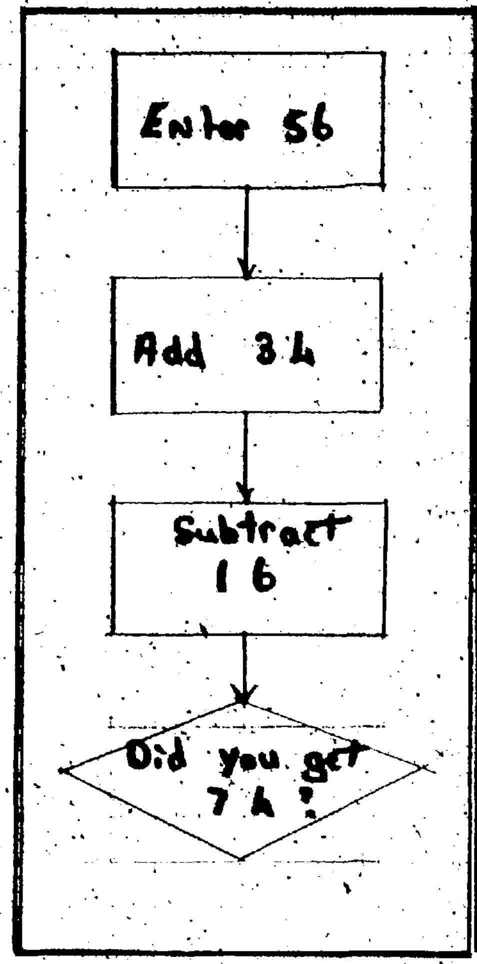
Directions:

1. At first the answers can be included on the card (Card 1).
2. Then the students can find the final answers and compare results with a partner, or the Task Card can be self-checking with the answer on the back (Card 2).
3. Some interesting problem-solving situations can develop by omitting a number other than the final answer. Discuss how the children solved the problems? "What relationships do they see between operations?" (Cards 3 and 4).
4. In a similar way, open-ended Task Cards make many solutions posible. "How many different ways can the children make Cards 5 and 6 work?"

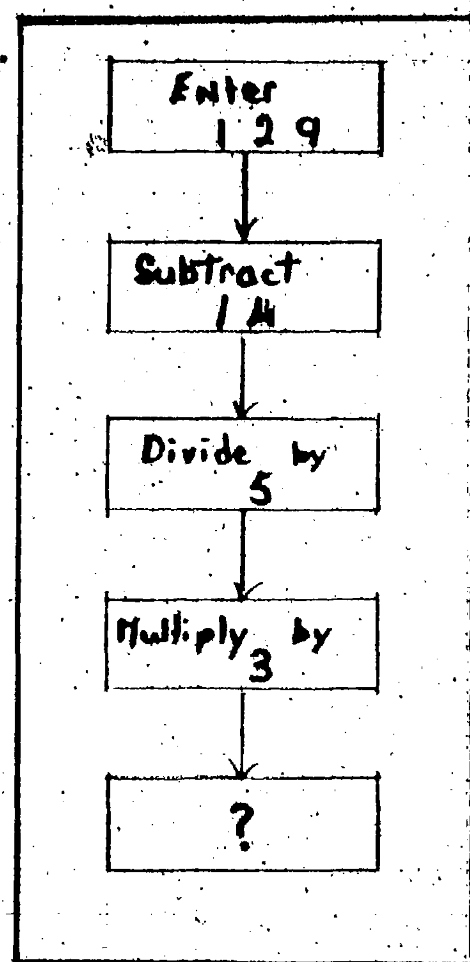
If this activity is enjoyable, you might suggest that children make similar Task Cards of their own for others to solve, using the calculator to help set up the problem and to verify solutions.

Task Cards.

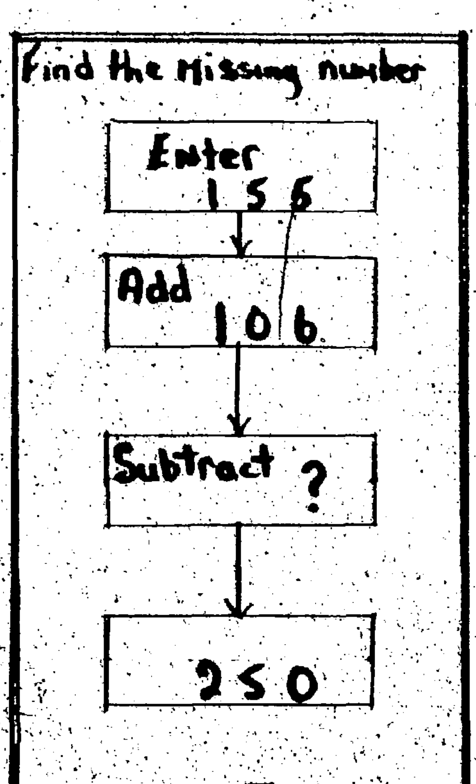
1.



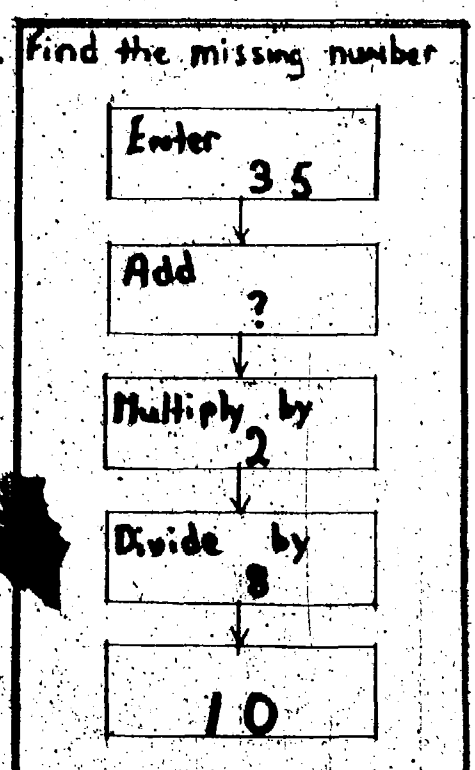
2.



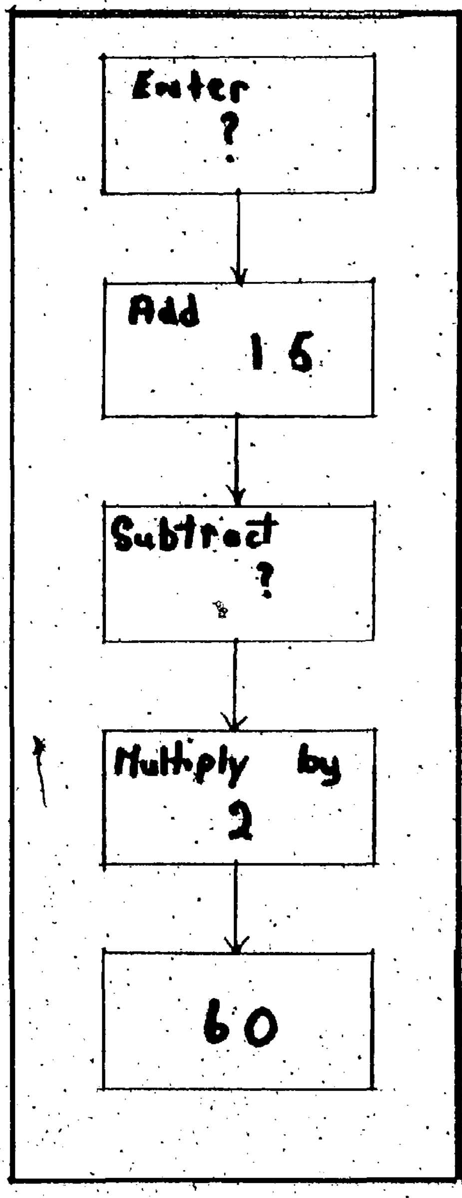
3.



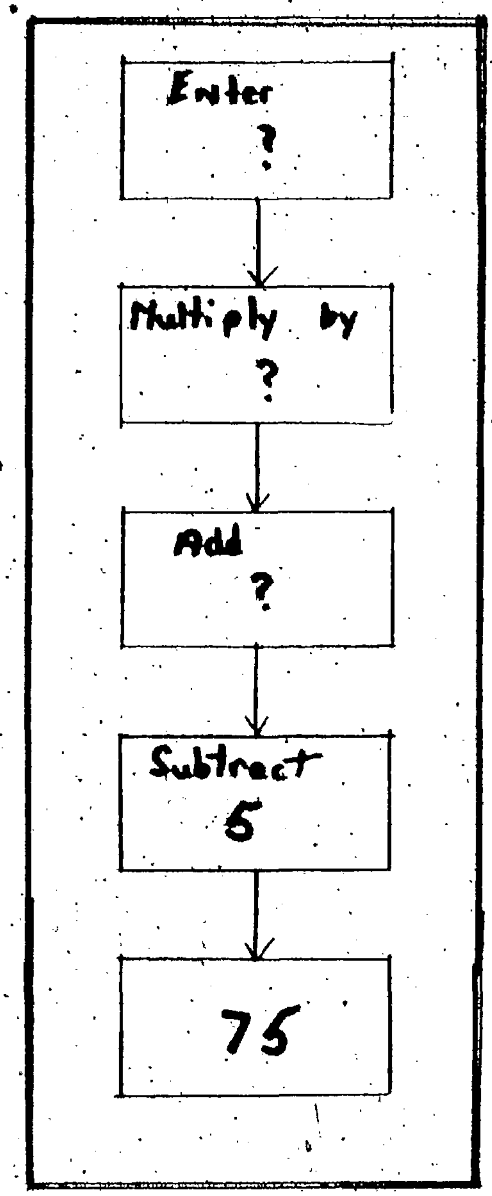
4.



5.


Enter
?
Add
16
Subtract
?
Multiply by
2
60

6.


Enter
?
Multiply by
?
Add
?
Subtract
5
75

5. CALCULATOR FUN.

Objectives:

To build competence in using the calculator.

To encourage the students to look very carefully at the visual display.

Directions:

1. Perform the indicated computations on a calculator.
2. To check your answer turn the calculator upside down and read a word answer. A clue is given for each problem.

CALCULATION	NUMBER ANSWER	CLUE	WORD ANSWER
1. (160*5)+7	-----	A tennis shot	-----
2. 456*81-1828	-----	The capital of Idaho	-----
3. 33624/6	-----	Mature pigs	-----
4. 394752/512	-----	Sick	-----

5. 2715+330	-----	Worn on the foot	-----
6. 584831-123456	-----	Vehicle for riding on snow	-----
7. 706-99	-----	A --- cabin	-----
8. 1884+1623	-----	To fail to win	-----
9. 15*247	-----	The bottom of a shoe	-----

---

* multiplied by

/ divided by

6. CALCULATOR GAME.

Objective :

To gain practice in using the calculator and to have fun.

Directions :

1. This is a game for two people and a calculator. You take it in turns to add 1,2 or 3. You choose which number, but you can only use these three keys.
2. The player who makes the total up to 21 (or more) is the one who loses.

Here is a sample game:

A starts with 1		B	Adds 1		Total	2
A presses	+2	B	"	+2	=	6
A "	+3	B	"	+1	=	10
A "	+2	B	"	+2	=	14
A "	+1	B	"	+3	=	18

Now A has to think : If A adds 2, then B has to lose, because the total is now 20, and the smallest number B can add is 1, which brings it up to 21. If A had added 1 at his/her last turn, B could have added another 1, making it 20. Then A would have had to lose.

* * * * * * * * * * * * * * * * * * *

5. THE VISUAL DISPLAY.

Calculator work and digital clocks encouraged the students to examine the visual display. The ability to read and interpret the visual display is an important function in computer work. The alphanumeric characters seen in calculator or in computer visual displays differ from familiar type and may be puzzling for the students at first sight. The objective of this section is to give the students practice in reading the various kinds of displays fluently, and also to foster an interest in these alphanumeric characters as an example of modern technological design.

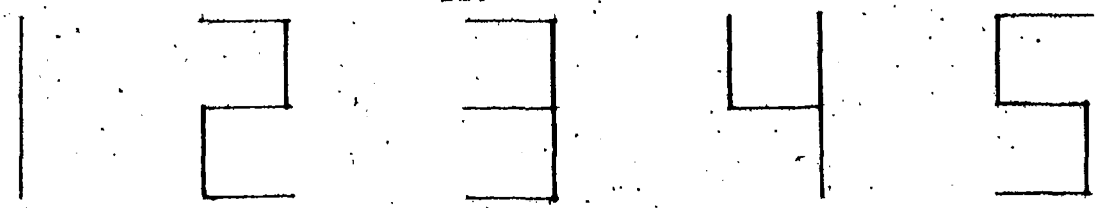
1. Numerals.

Childrens' attention should be drawn to the shape of the numerals in electronic clocks, digital watches or calculator visual displays. They will be encouraged to discover that these numerals are made up of straight lines, and that short straight units are used to replace curves.

Observation Activities.

a) Collecting illustrations of numerals on visual displays. Each student can examine the straight-line structure by moving his/her finger along the numeral in a straight-line motion.

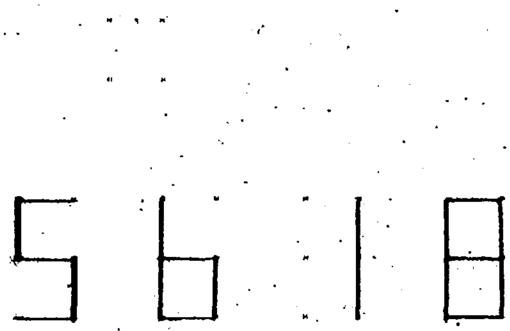
b) Copying the actual shape from the visual display, enlarging at the same time.



c) Making copies of the shapes of the numerals with matchsticks or mathematical rods (all the same length at first).

d) Building numerals using six dots (two, two and two) and straight lines. For example

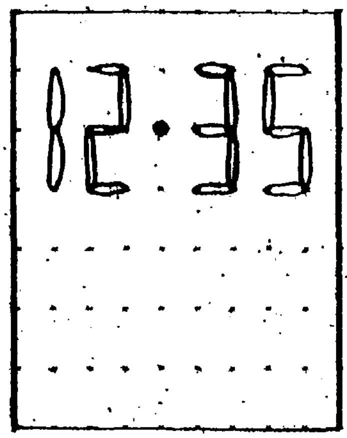
Six dots



5 moves 5 moves 2 moves 7 moves

Children will discover that when using these six dots to make visual display numerals they can get 1 in two moves, 7 in three moves, 3,5,6 and 9 in five moves, while 0 needs six strokes, and 8 shows the complete pattern of these 'elements' or segments from which the numerals are built up. This is called a seven-segment display. In some visual displays each segment is lit up seperately, while in others, e.g. most watches, each segment goes dark against a lighter background. Children are encouraged to look for some examples of these.

e) Making display numerals on pegboards; with six pegs per character and small rubber bands to loop around the pegs to form vertical and horizontal lines.



Pegboard, pegs and rubber bands.

Using this method the children can make two-, three- and four-digit numbers, They can also make models of digital times as seen on digital watches and clocks. A coloured peg could be used to seperate the hour from the minute numerals.

f) In calculator work the students discovered that by inverting the calculator some of the numerals could be read as letters. This fun activity can also be applied to the peg board where the students make numerals with pegs and rubber bands, then invert the board to see the letters. Activities to think out and make three-, four-, and five-letter words are very enjoyable and good for their vocabulary work as well.

g) Another activity which can lead to even closer examination of the structure of these numerals is looking for examples of symmetry and mirror-imagery in the numerals. This will be more suitable for students who have already worked on symmetry and mirror images. Some of the numerals, e.g. 8,0 and 1 are symmetrical, while 5 and 2, and 6 and 9 are mirror images of each other.

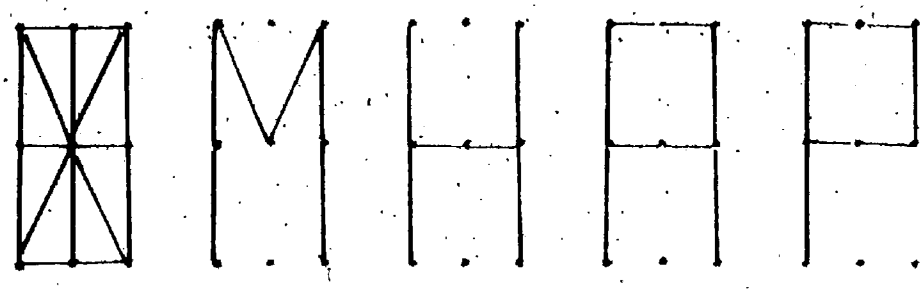
2. Letters.

The students will discover that making letters by this straight-line method is more difficult than making numerals, because of the need for diagonals and curves. One way to make these letters is to use a larger number of segments e.g. sixteen segments.

Activities similar to those for numerals can provide practice in making these letters, e.g.:

a) Building letters using 9 dots and straight lines.

b) A pegboard, 9 pegs and rubber bands.

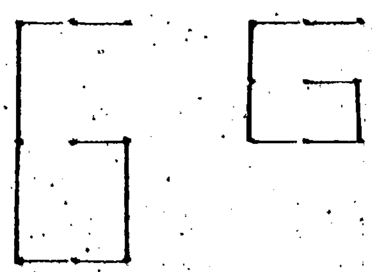


16 segments

3) Making all the letters of the alphabet.

4) Making short words, students' own names etc.

5) Children are encouraged to experiment with the size of their segments, and a discussion may arise as to the best design for certain letters.



Which is better?

3. The DOT MATRIX method.

Although the children will make acceptable letters using the sixteen segment method it will be obvious to them that this is not ~~the best way~~ for making letters. At this point the teacher could introduce the DOT MATRIX method. This method of creating display uses many small dots, each of which can be lit or darkened seperately.

Some suggested activities.

a) The students are encouraged to find examples of dot matrix letters and to copy the design onto paper.

b) The students can make each letter on a pegboard using pegs. As they become adept at this the teacher could encourage them to make all the letters a standard size. Once again the best height and width can be agreed upon after experimentation and discussion. This activity can be done on squared paper too.

c) As well as letters they can also make numerals.

Now they should compare these letters and numerals with those they made using the straight-line method. 'Which kind is easier to read?; easier to make?', etc.

d) Lower-case letters.

The students could try to design lower-case letters on their pegboards or squared paper. This could prove to be more difficult than capital letters because of the 'tails' on some of the letters which have to be flattened. This activity could lead to the students examining a computer print-out using lower-case letters. They should observe that it is more difficult to read than upper-case. However they should make every attempt to become competent in reading such printouts. Because upper-case letters are easier to design and read, most computers use them.

e) Improving the designs.

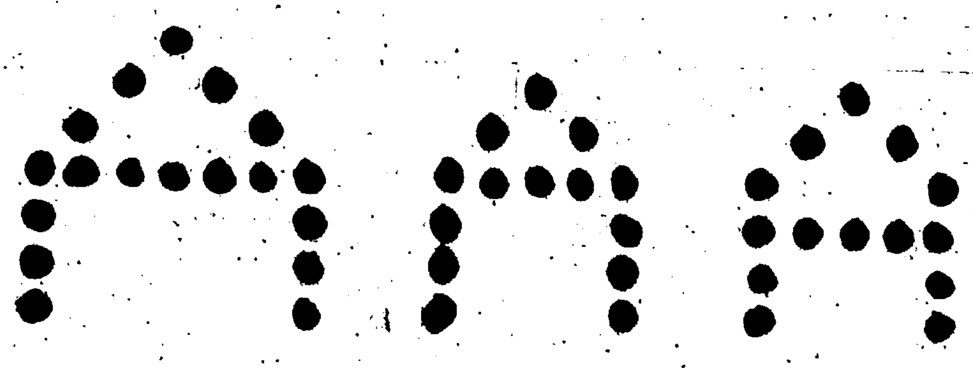
An experiment: i) Children are presented with two kinds of squared paper, one with large squares, one with small squares.
ii) They choose a letter that has at least one curve in it ,e.g. S or B.
iii) Then they fill in the squares to make the letter they have chosen - the dot matrix method, using the two sizes of squares. The letter must be the same height each time.
iv) Now examine the two designs. Compare them. Which one is clearer, has smoother curves, is more accurate? They should discover that the letter made with the smaller squares is better.

The important objective of this experiment is that the students will make the important discovery that the smaller the squares, the better the design. This is an important factor in the design of computer printouts and VDTs.

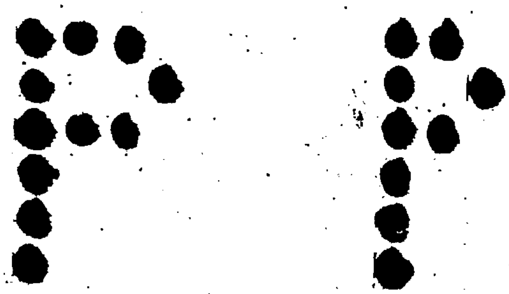
f) Extending the Dot Matrix.

The dot matrix method involved filling squares with 'dots' to make a design. An extension of this method would be for the students to create designs using small blocks or squares to make a design. Activities such as mosaic work, collage or other activities involving small square units can be fun and require thought and planning of the student.

Dot matrix.



Which is better ?



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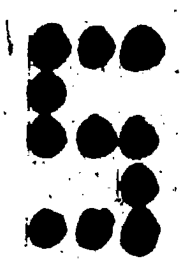


S or 5 ?

6. GRAPHICS.

Computer graphics will not be a new concept for many of the students. They will have seen examples of this graphic style in video games, television commercials and printed material. Some objectives for this section are that the students will become familiar with and have fun making computer style graphics; that the students will understand the concept of every square having its own standard space; and that they will be able to name and find points in a grid, i.e., understand the concept of addresses.

Let's Make Computer Pictures.

a) Children are encouraged to 'draw' pictures using sheets of squared paper (or graph paper):

Draw a tree; a dog; a spaceman; a ball....

Children will discover that it is difficult to draw small details, and that the smaller the squares the more accurate their designs will be.

At this point the teacher should try to emphasise the point that a grid (a large number of regular spaces, or squares in this case) is important for the material we put into the computer as well as in the design of the computer output.

b) We extend the drawing of pictures using squares on a grid to naming the squares on the grid that we use.

The procedure can take this form:

1. Give each child a small grid (see diagram 1) with the squares across numbered.

2. Students are encouraged to count the number of squares across the grid, pointing to each square as they count. First count the number of squares on the first row across; the number of squares across the bottom row; across the middle...

3. Next allow the students to put their finger on the first square in a row. "How many squares have I MOVED across? None, because I stayed on the first square. So we can say that we are on square Ø - a name for this square."

Students move their finger onto the next square across. "How many squares have I moved across? One. Look above you and you will see the number 1." Continue like this for all the squares across the row.

4. To reinforce this the students could be asked to find the square at 4 on the row across, the square called 8, the square at 3...

When students demonstrate an understanding of this system they can now begin to learn about the squares down the grid.

5. Give each child a grid with the squares down the left hand side numbered. Repeat the procedure for this grid naming the squares down the row. (See diagram 2)

6. Introduce the students to the concept that the 'name' of the square is another name for its 'address' - the place where it can be found.

7. Give each student a grid of squares with the numbers both on

top and down the side. (See diagram 3) They learn that to give the full address of a square they must give its address across the grid first, and then its address down the grid. The teacher demonstrates by colouring in a square on the grid. "What is its address across the grid?" Children are encouraged to find this address either by moving their finger across the grid and counting the distance moved, or by looking at the number of the square on the top. Then they are requested to find its address down the grid. When they have been successful in finding the correct address across and down they are shown how to say it correctly, and how to write it. For example on diagram 3, this square is four, five or (4,5).

8. Students can plot whole pictures on squared paper, having written down the numbers across the top and down the left-hand side, and can then give their partner a list of 'addresses' from which the drawing can be constructed by this student who has never seen the picture. Students will discover that it is possible to reproduce the design exactly if the instructions or addresses are given correctly.

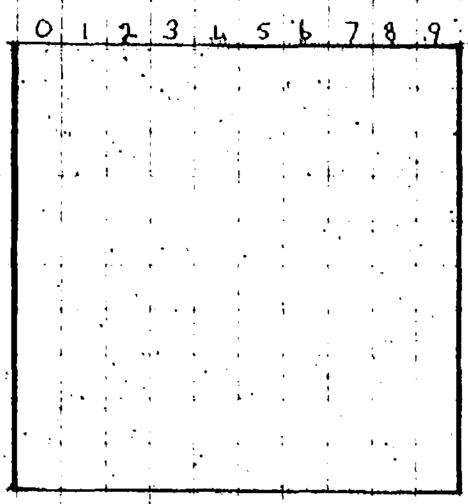
9. Another activity is to have a group of students contributing addresses of squares, one at a time, building up into a picture.

10. When the teacher feels that the students understand and have demonstrated competence in naming addresses of squares on a grid, it may be an appropriate time to introduce the concept of naming points on a grid or a VDU screen. Instead of naming the squares they will learn to name the points at which the lines of the grid cross.

11. Give each student a grid of squares. Demonstrate how to number the lines instead of the squares (diagram 5). Then show them how to mark in all the points on the grid, and give the addresses of each point.

12. Activities similar to those for addressing squares can be used to give the students practice with plotting and addressing points.

1.



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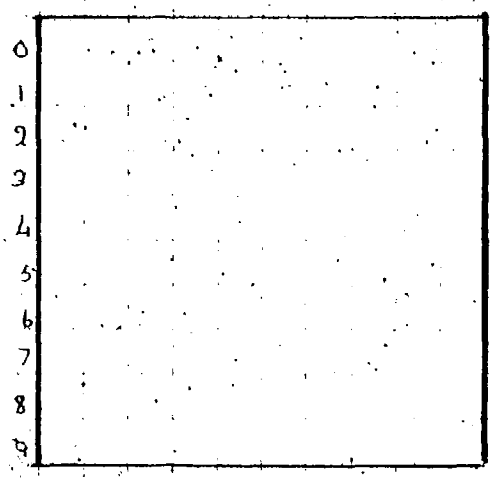

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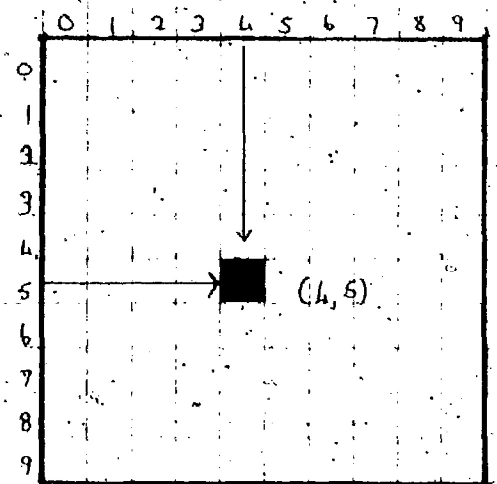

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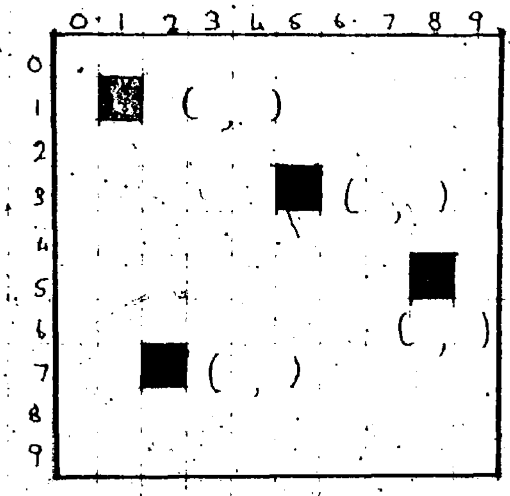
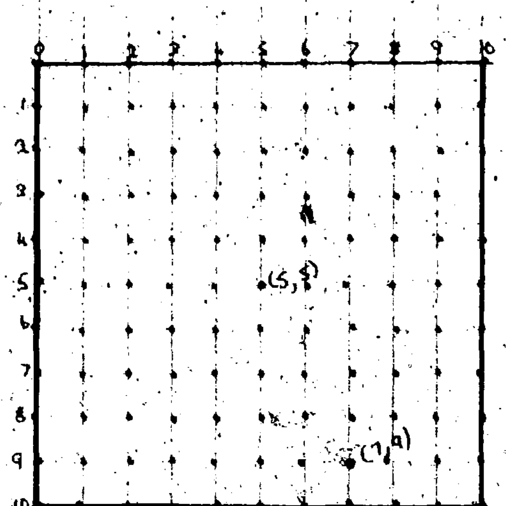


Find the addresses

5.



7. THE KEYBOARD.

By pressing the keys on calculators and keypads the children discovered that they were in fact giving instructions to the calculator, telephone or automatic teller. They also discovered that these instructions must be given in a very exact way, as this is the only way the machine can understand the instructions. This concept of specific instructions was reinforced when the students explored 'addresses' and how to name points on a grid so that a drawing could be constructed from their instructions. This concept of exact instructions is a fundamental element in preparation for computer work, as it is the basis for all computer input. So far, the students have explored input or messages in terms of numerals, mathematical symbols, and addresses for creating graphics. Messages can also be given to the computer in letters and words. It is a combination of all these different kinds of messages or input that form the basic contact between user and computer - they are our means of telling the computer what to do with these words and figures that we give it. As the keyboard is a source of input into the computer, it is a worthwhile experience for the child to become familiar with the keyboard and to become confident in using one. This section will introduce the students to the keyboard and encourage them to use it successfully, while helping them to become familiar with reading typewritten messages.

The Keyboard.

a) Begin this section by introducing the students to the typewriter keyboard. A real typewriter is necessary for this section. Typewriters may perhaps be borrowed from parents, friends, the school secretary... Even old typewriters are valuable as they too provide the necessary experience for the student.

- Instructions for students:

  Always put paper in;

  Press only one key at a time;

  Don't hit the keys too hard.

Students should be given time to explore the keyboard on their own initially, then encouraged to type letters going from left to right along the rows. "How do you make capital letters"? "Find a,r,p etc."

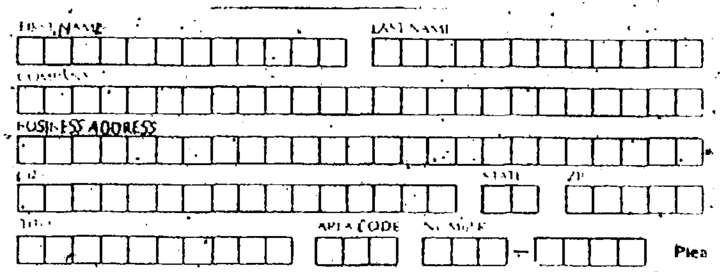
- Children type their own name and the names of their friends.
- Children type words,
- and finally they type in sentences and messages. They are encouraged to type messages to each other, and to read these messages aloud.
- Other activities include finding the most-used and the least-used letters; making patterns using just one key/letter like a cross stitch pattern; typing classroom notices, etc.
- Collecting different kinds of typewriter print and comparing

them. "Which is the clearest, the easiest to read...." These could also be compared to computer printouts that the children have already seen.

b) As the children gain experience in using the typewriter keyboard they will discover the regularity of the typewritten text. It is a valuable experience to allow them to first of all guess and then test the total number of characters, including spaces and punctuation marks, in a line of typing. This should be developed into measuring the length of a line of typed letters, e.g. 50 times the letter 'l',and 50 times the leter 'm'. They will most likely guess that the letter 'l' would take up less width than a 'fat' letter such as m. They will discover that both letters (all letters in fact) take up the same space.
- A more complicated activity : Typing a single letter as a starter and then 48 spaces and a single letter again at the end. "Do spaces take up the same room as letters"?
Do this also for a line of full stops or commas. The essential point to be grasped is that all letters, punctuation marks, and spaces have their own standard space.
- Children will be required to look for examples of giving each letter or numeral its own standard space. Some examples might include crossword puzzles and forms for filling in names and addresses. Crossword puzzles could be explored to great advantage in the classroom as it would benefit vocabulary, spelling, definitions, etc.; as well as reinforcing the concept of standard space. Crosswords could easily be adapted to the age

and ability of the student and so provide an enjoyable learning activity.

- Collecting old forms and tear-off slips with rows of boxes into which one is expected to write one's name, letter by letter, will give the children more practice in writing in standard spaces, as well as giving them a little practice in filling out this type of form - a useful skill.



B. COMPUTER INPUT.

The students are familiar with giving information and instructions to the computer by sending messages from the keyboard or number pad. They are aware that these instructions must be correct and in the right order. The computer is a machine and therefore cannot think, so the thinking must be done by the person who gives the instructions. When the children are comfortable with these ideas, it would be a valuable experience to introduce them to Hony different ways we have of giving information to the computer. This section will introduce the students to such input devices as magnetic tape, magnetic disks, bar codes, keyboards, light pens, graphic tablets, magnetic ink and pencil marks. To use all of these devices would probably be beyond the scope of the regular classroom, but the teacher can make the students aware of their existance and function through illustrations, discussion, perhaps borrowing these devices and allowing students to experience them concretely for a short time, or even planning an outing to see some of them in operation in the environment.

(a) The Keyboard.
The students will have already been introduced to the keyboard as a means of typing messages. They should be reminded that typing on the computer keyboard and watching the messages appear

on the computer screen is actually sending messages to the computer, and that when they press the ENTER or RETURN key on the keyboard, the messages that they have input are now stored in the MEMORY of the computer.

The computer's memory is a new concept encountered by students, and perhaps the teacher could explain it as 'space' inside the computer where information is stored.

Children should be given plenty of time to practice typing messages on the keyboard, pressing the ENTER key and reading the message from the screen. This is great preparation for future computer work as they are building up familiarity with the hardware in a fun, non-pressured atmosphere. The progression to formal computer work is only a small step away.

(b) Magnetic Tape.

Second to the keyboard, the magnetic tape input method is probably the most common input method in the classroom. Most of the students will be familiar with the regular tape recorder and tape, so the actual hardware will not seem so new. The teacher should load and run a computer program from tape. He/she could allow the the children to look at the blank screen before the tape is loaded, then put the tape into the tape recorder, connect it to the computer, load it into the computer, then run the program and allow the students to use it.

Some questions: "What was on the screen before I began? What is on the screen now? How did it get there?"
Children will be encouraged to discuss what they observed the

teacher doing, and should make the connection between the tape recorder and the program in the computer.

- The teacher should now explain that messages come from the tape in the tape recorder to the computer. These messages that make up a program are stored in a special way on the tape. It is much quicker to store many messages on tape than it is to type in all these messages on the keyboard every time we wanted to use that program.

- The students should be shown how to insert a tape in the tape recorder and how to load the program into the computer.

As this is a fairly simple task most students could master it with a little practice. To aid this learning even more, a list of instructions could be posted above the computer, using simple words and illustrations that all could understand.

(c). Magnetic Disk.

The teacher could use a similar process to introduce the disk as was used for the tape and tape recorder. Insert a disk in a diskdrive, load the program into the computer and run it. "Where did the program come from? What did I do to put the program in there?"....

Remove the Disk from the diskdrive and show it to the students. Explain that it is called a disk and that information is stored on it.

- The diskdrive should also be explained. Like the tape recorder that gets the information from the tape and passes it on to the computer, the diskdrive sends the information from the disk to the computer. The disk can store much more information than a tape, and with a diskdrive the information can be sent very quickly to the computer.

(d) Bar Codes.

Most of the students will have observed bar codes on many items in their homes and in school, e.g., tins of food, coke bottles, books, etc., and may wonder what they are for. These bar codes can be read by special 'readers' in computers even though we cannot read them. The best way to explain their function would perhaps be to take the students to a supermarket, select an item or items with bar codes and present them to the person at the checkout. The students will be asked to watch what happens. The person there will run a special sensor across the set of lines and the price will automatically be fed into the cash register.

Another way to observe bar codes being used would be to visit a library. Each book has a bar code and each borrower has a card with a bar code too. The librarian uses a sensor to read the the bar code belonging to the borrower and the bar code on each book that the person borrows. The computer is programmed to record the loan.

- Back in the classroom the students can study examples of bar codes. Each strip has a line of black numbers along the bottom of the black lines. Some students may connect these numbers with the way the thick and thin lines are arranged. Other activities might involve trying to find a connection between the bar codes or numbers on a small tin and a large tin of exactly the same

product. They could also interview a store owner and ask him/her about the bar codes : "Do they use them? Why does he/she use them? Do they make working in the shop easier? How else do they help the people who work in the shop?..."
A librarian could also be interviewed in a similar way.

(e) Light Pens.

The best way to make the students aware of this input device is to allow them to use it. We can communicate with the computer very easily using a light pen. We simply point to the places on the screen and the computer responds. This will be highlighted for the students if they use a light pen with a program designed for this purpose. Discussion could center around these questions :

"What happens when I touch this square with the pen? If I touch it with my pencil or with my finger what will happen?..."
Through exploration the students will discover that the light pen inputs signals to the computer.

(f) Magnetic Ink.

Examples of this type of computer input can be found along the bottom of cheques. These odd-looking figures are printed in special magnetic ink. They have a special shape so that the magnetic sensor or automatic 'reader' can identify each figure without mistake. Students can collect samples of these and compare them. A magnifying glass would be very useful to show up the unusual shapes more clearly.

(g) Graphic Tablets.

This method of input will perhaps be the most popular with the students, and 'hands-on' experience is a must. The students will discover that what they draw on the tablet will be input to the computer. This device sends messages to the computer, and allows the computer to reproduce the students' designs. The students should be allowed to experiment with this as much as possible as it provides great scope for creativity and enjoyment, as well as worhtwhile learning.

(h) Pencil Marks.

This method of computer input also requires the computer to 'read' marks. This time the marks are made by pencil. This method is usually used for marking test questions, or for collecting answers to questionnaires. The person filling in the special form will use a pencil to fill in small squares or circles on the answer sheet, and the machine is able to detect these marks. Here is an example of a sheet requiring the person to fill in with a pencil, and based on these marks the computer will know what information the person requires.

children can be encouraged to collect examples similar to this and can practice filling them in.

ADVERTISED PRODUCTS

1	13	25	37	49	61	73	85	97	109	121	133	145	157
2	14	26	38	50	62	74	86	98	110	122	134	146	158
3	15	27	39	51	63	75	87	99	111	123	135	147	159
4	16	28	40	52	64	76	88	100	112	124	136	148	160
5	17	29	41	53	65	77	89	101	113	125	137	149	161
6	18	30	42	54	66	78	90	102	114	126	138	150	162
7	19	31	43	55	67	79	91	103	115	127	139	151	163
8	20	32	44	56	68	80	92	104	116	128	140	152	164
9	21	33	45	57	69	81	93	105	117	129	141	153	165
10	22	34	46	58	70	82	94	106	118	130	142	154	166
11	23	35	47	59	71	83	95	107	119	131	143	155	167
12	24	36	48	60	72	84	96	108	120	132	144	156	168

NEW PRODUCT ITEMS

300	307	314	321	328	335	342	349
301	308	315	322	329	336	343	350
302	309	316	323	330	337	344	351
303	310	317	324	331	338	345	352
304	311	318	325	332	339	346	353
305	312	319	326	333	340	347	354
306	313	320	327	334	341	348	355

MANUFACTURER'S LITERATURE ITEMS

400	407	414	421	428	435	442	449
401	408	415	422	429	436	443	450
402	409	416	423	430	437	444	451
403	410	417	424	431	438	445	452
404	411	418	425	432	439	446	453
405	412	419	426	433	440	447	454
406	413	420	427	434	441	448	455

Architectural Record Reader Service Card
March 198[illegible]

Please check profession and type of business

I Profession (check one)
Registered Architect A
Engineer B
[illegible] Architect C
Interior Designer D
Designer E
Draftsman F
Other ______ G

II Type of business (check one)
Architectural, or Architectural Engineering H
Consulting Engineering J
Contracting K
Commercial Industrial Institutional L
Government M
Other ______ N

III Information needed for
New building P
Remodeling Q
Both R

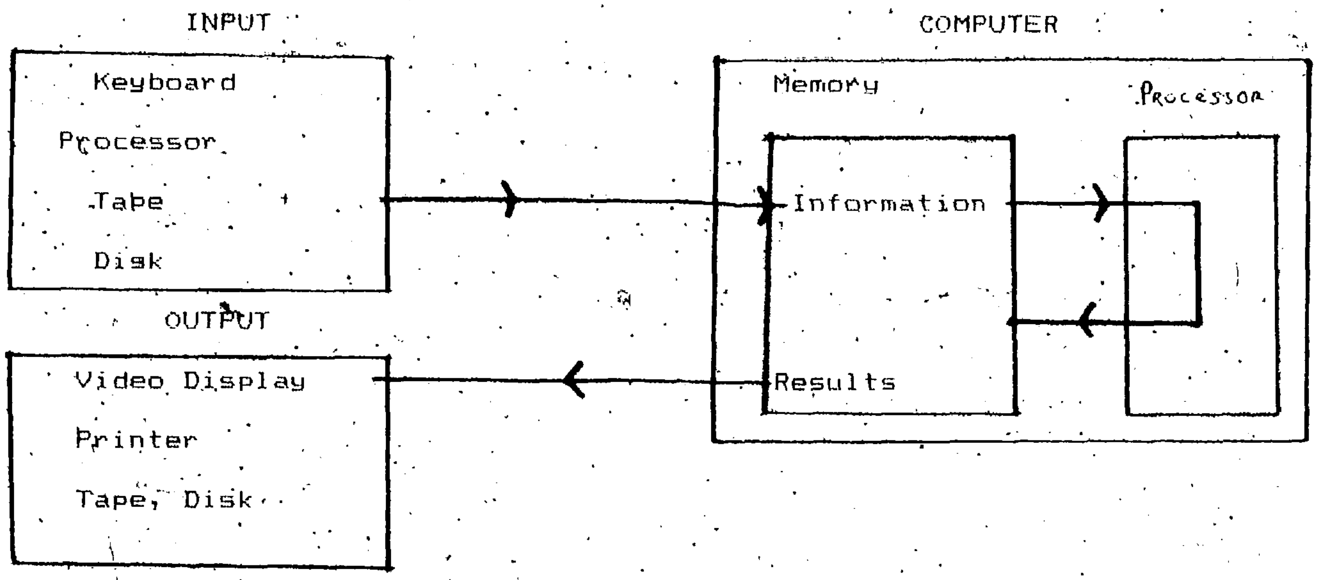
IV Send me information regarding a subscription to ARCHITECTURAL RECORD 999

9. PROCESSING AND COMPUTER OUTPUT.

The previous section introduced the children to the various ways we input information into the computer, and that this information is stored in the computer's memory. This section seek to briefly inform the student what happens to the information in memory, and to give the student an opportunity to see the different kinds of computer output.

(a) Computer Processing.

When people give instructions they expect these instructions to be carried out. When we give instructions to the computer we expect the computer to act upon these instructions and to give us the results. The information that we input into the computer goes into the memory. Here the computer decides what it has to do with the information. The computer processes the information in a special area inside the computer - the PROCESSOR. When it is finished the results are sent back to memory and stored there until we request to see them. The teacher could explain this process by simple illustrations, e.g.:



(b) OUTPUT.

i) Video Display Units (VDUs).

One way the computer shows us results is on the VDU. The computer sends the results of the program in letters, numerals and graphics to the computer screen where we can read them. By this method of display we can read the results quickly, and the VDUs leave no waste paper. But this also means that the output disappears quickly. The students will be asked to read the output from a program on the VDU.

"Is the output clear? Is it in numerals, letters and words, or in graphics? Is dot matrix used? Is it colourful? Does it move (animation)? Is there sound to accompany the text or graphics?" Such questions and discussion will make them more critical, as well as more appreciative, of what they see. Students will be asked to look for other VDUs in their environment, e.g. travel agent, bank.., and to find out what the results show.

2. Printed Results.

The results of a program can also be printed on paper. We need a printer if we want our output to be typed. To fully explain this it would be best if the students could watch a printer in action in the classroom. They should be given the opportunity to look at the print : "Is it dot matrix; is it clear; can you read it...?"

The speed of the printer could also be a source of discussion. "Is it fast or slow? Is it faster than a typewriter?.." Pupils could be asked to compare the output from a VDU with the output from a printer. This could be extended further to include books and TV - all as sources of information and data. This exercise should stimulate thought and discussion and is worthwhile.

3. Tape and Disk.

Just as we input information and data on tape and disk we can store results on them too. In this way the results will be available when we want to see them. Some suggested topics for discussion:

"How will we look at the results that we have stored?"

"Why is it a good idea to store our results in this way?" .....

10. A COMPUTER MODEL.

Now that students know about giving instructions, input and output, and have been introduced to the concepts of memory and computer processing, it would be a useful exercise to combine all of these and make a model computer. In this kind of computer model, individual students would play the role of the various computer components and carry out the instructions required to run a program. This would make a computer operation come alive for the students and give them direct experience of the process. The aim of having such a model is that all students will understand and become involved in the process.

Making an Active Classroom Model Computer.

1. Choose a simple process, for example 2+4+6+8.
2. All the data and instructions are printed on large cards. The cards for our suggested activity will be :

START	2	4	6	8	+	+	+	=	=	=	STOP

3. Six students are involved and they need large labels :
INPUT PERSON, INPUT, MEMORY, PROCESSOR, OUTPUT (or VDU), OUTPUT READER PERSON.
4. The students need a clear space, with two tabels in the

centre and one at each end. These tables need to be clearly marked :

INPUT, MEMORY, PROCESSING, OUTPUT.

The Model At Work.

1. The INPUT PERSON hands to INPUT, across the INPUT table, the cards with the data numerals and the operation symbols on them. These are already sorted into the order in which they will be needed. This order will be : 2 + 4 = + 6 = + 8 = STOP

2. Input takes them to MEMORY at the MEMORY table. MEMORY puts them on the right-hand side of the table and looks at them.

3. MEMORY hands the first four cards 2,+,4,= to the PROCESSOR at the PROCESSING table; these will be the material that the PROCESSOR will deal with first.

4. Now INPUT PERSON hands to INPUT the card START which is then handed to the PROCESSOR.

5. The PROCESSOR now does the addition sum 2+4 on the PROCESSING table, and writes the answer 6 on a blank card, in large print so that the onlookers can see.

6. PROCESSOR now gives the used cards (2,+,4,=) back to MEMORY who places them on the right-hand side, seporate from the cards from input. Then MEMORY hands the next three cards (+,6,=) to the PROCESSOR who adds 6 to the result from the first step (6) which he/she wrote down.

7. Having done the second addition (6+6) he/she writes his/her

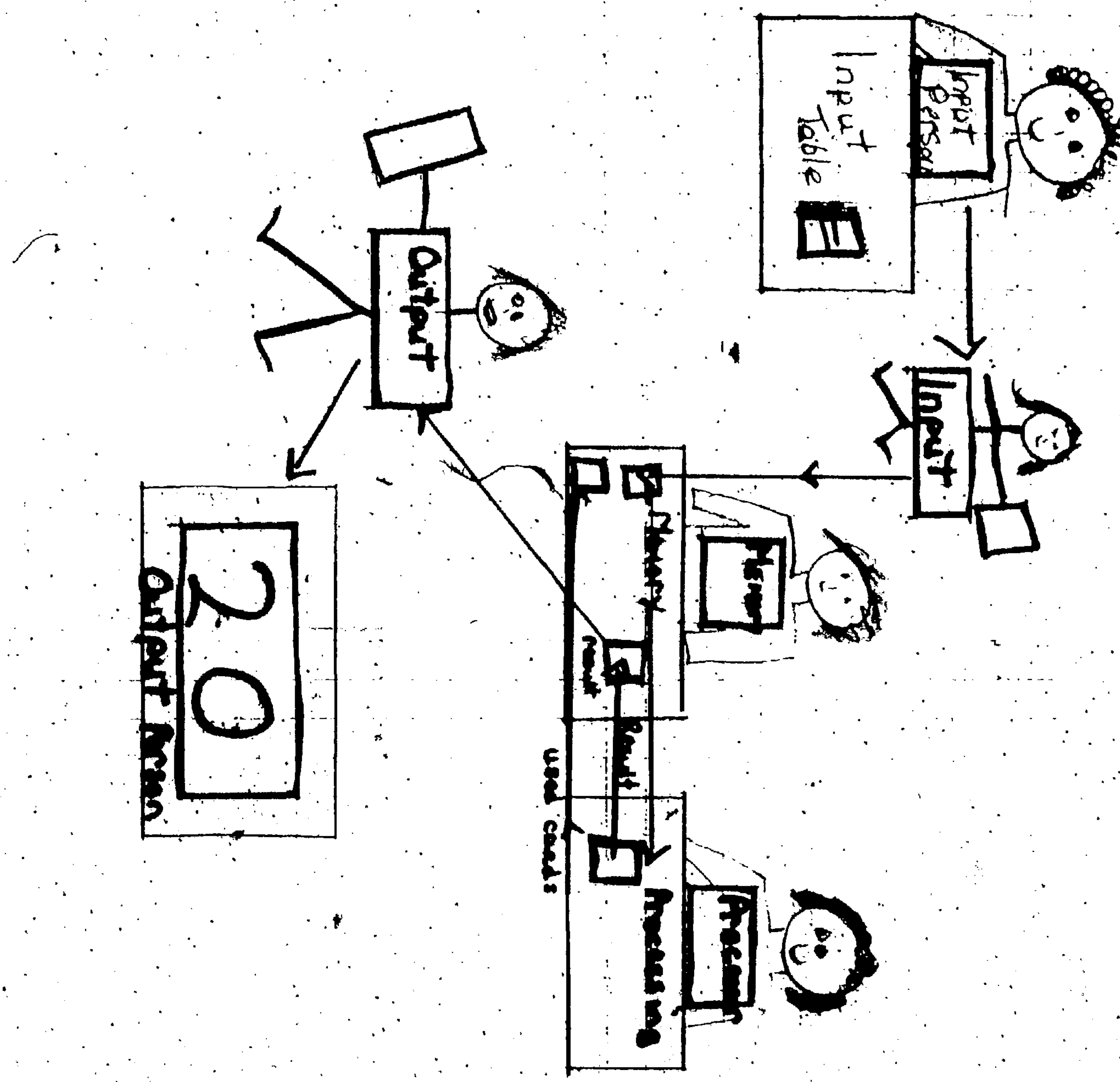
second result card (12), and hands the used cards back to MEMORY who puts them in the second pile.

8. Each step involves collecting just the cards needed for that one step, and writing the result card, which then becomes the starting point of the next step.

9. When the PROCESSOR has added 12+8 and has written the result on a blank card, the next card from MEMORY says STOP. PROCESSOR can then hand the result card (20) to MEMORY who places it on the left-hand side of the table. Then MEMORY gives this card to OUTPUT who holds it up so that the OUTPUT READER PERSON can read it. To simulate a VDU, the output card could be held behind the front window of an old TV set, making the output into a model of a real VDU.

10. This whole process should go smoothly with a little practice and can be done without any speaking. Preparation in the form of devising a program, writing the data and instrucrion cards, and putting the cards in the correct order (a flowchart might be used to prepare for this), would involve the whole class. Each child should be given an opportunity to take part in the model computer.

Classroom Model Computer.



11. The COMPUTER WORLD.

This section aims to have the children constantly learning more about the computer world around them. It seeks to be an ongoing process of making the students computer literate from a young age. This unit has so far introduced the students to skills and concepts necessary for a good beginning with computer work. Some topics have encouraged the students to explore their environment to find examples of computer technology and modern equipment. This is the beginning of an effort to make the students aware of the influence of the computer in our society and the implications of that influence. Activities with these aims in mind might take the following form :

1. Outings to visit places in the environment where computers are used. Students will be encouraged to discuss with the people involved the funcion of the computer; how it helps in that office, shop... They will be encouraged to talk to the people who operate the computer and to those who program it.

2. In talking to people involved with computers, it is important that the students learn that without people computers are just bits of silicon, metal and plastic. They ae invented by people, programmed by people, and switched on, and off, by people. People control computers and everything they do.

3. Finding out through people, newspapers, magazines, books, TV, etc., as many different uses for computers as possible. The depth to which this can be explored depends on the age and ability of the students. They should discuss as many advantages as possible and then list the disadvantages. Do the advantages outweigh the disadvantages?...

Such knowledge and awareness, as well as their growing skills in computer work, will give the students the confidence to know and feel that they are part of the computer future.

PART 2.

BEGINNING LOGO.

BEGINNING LOGO.

INTRODUCTION.

Teaching Logo (the computer language developed especially for children by Semour Papert (1)), to young children is more than introducing them to a programming language. They are being introduced to a whole philosophy of education. This philosophy is strongly influenced by Piaget and his theory of how children learn. Piaget recognises that every learner takes an active role in his/her own development, and that learning is a primary, natural function of the healthy mind (2). Papert supports this theory in claiming that a child learns partly by picking up specific facts and skills. But a more important kind of learning is the skill of learning itself, which involves building mental models of the environment through intellectual exploration. Logo provides a sort of laboratory for loose lifelong learning about learning, and gives the child the opportunity to develop his/her cognitive abilities to full potential.

As a computer language, Logo is both simple and powerful. It's simplicity makes it possible for beginners to write simple programs that do interesting things. It gives the children control over powerful computational resources, which they can use as tools in learning, playing, and exploring. With turtle graphics it is veny easy to to start programming. The basic commands are simple and have simple visible effects. When the children explore using Logo, they are constantly defining new procedures and modifying old ones. Learning is a gradual process of familiarization, finding problems, and trying to resolve these problems by proposing and testing simple ideas in which new problems resemble others already understood. With few instructions from a teacher, students can adopt Logo as a personal and powerful problem solving tool with which they can translate abstract and complex problems into accessible, concrete, and simple forms.

Logo begins with what children already know about moving themselves through space. They use this knowledge to direct the turtle that moves on the computer's graphics screen. In attempting to achieve particular effects, students become engaged with estimation, matching, rotation, prediction, and debugging. Logo encourages the student to break down complex problems into manageable parts, solving each seperately until the whole problem is completed. The importance of such exploration is the genuine sense of discovery students get when they pose their own problems, devise their own methods to solve them, and perhaps recognise some pattern or relationship that they had never noticed before.

When a child makes a mistake or has a 'bug' in the program, he/she can try another approach or explore the mistake even further. This ability to debug ideas and to gradually work towards a solution to a problem reflects the Piagetian view of learning. The child is encouraged to look on a bug as a source of information about what to do next rather than as a proof of failure. In this, Logo makes a great contribution to teaching children how to problem-solve. And, as Logo sharpens their thinking skills, it also develops a good foundation in programming and computer concepts. Logo teaches the child to understand the underlying structure of programming and problem solving, and teaches good thinking habits, so the student will be able to apply these skills to any problem, no matter what computer language they may be expressed in.

Teaching the Logo language and introducing Logo activities to young children can form the basis for several different kinds of learning. The major learning goals for teaching Logo in this unit are :

1. Learning to feel comfortable with a computer, and in control of what the computer does. The child will learn that he/she can decide what the computer will do, and have the computer carry out a set of instructions.

2. Learning the elements of the Logo language. This includes the Logo commands, how to write and name procedures and subprocedures, and how to define, name and use variables.

3. Learning the 'subject matter' of turtle geometry. This includes concepts of measurement and estimation of angles and

distances; and the relations among angles and distances necessary to make shapes such as a square, triangle, circle, etc.

4. Learning to develop problem solving skills. This includes such things as procedural thinking, 'playing turtle', the concept of a 'bug' (and trying to resolve it) in a computer program, and strategies for debugging and planning; and the development of a language with which to discuss all these things.

The following Logo guidelines are designed to be flexible enough to serve as a vehicle for many different patterns of learning. An important part of the design of the activities was making decisions about what students would learn and what strategies the teacher would adopt to bring this about. Part of the strategy is that while the teacher would exert some pressure for the student to achieve the objectives set out for them, he/she would also allow deviations if he/she felt that a particular student would not respond to the pre-determined goals. Every student will learn in a different way, and the role of the teacher is to guide that learning in such a way as to enable each student to reach their full intellectual potential. The activities are flexible and can be adjusted to suit the needs of the individual leanner and the rate at which each student learns the new Logo concepts. Some time guidelines are suggested in a few of the activities, but these are simply suggestions. The teacher will be the best judge as to when each individual student is ready to move on to the next step. It may take up to two years to cover the entire unit.

REFERENCES.

(1) Papert. Seymour, 'Mimdstorms : Children, Computers and Powerful Ideas.' (Basic Books, New York 1980).

(2) Piaget, Jean, and Inhelder, Barbel. 'The Psychology of the Child.' (Basic Books, New York 1969).

LOGO ACTIVITY 1 : LEARNING TO COMMUNICATE.

Students are put in a situation where they must informally invent their own language for communicating geometrical ideas.

TIME

At least three half-hour class periods.

FORMAT

Whole class discussion plus work in pairs.

MATERIALS

Squared paper.

Objectives.

1. Students should be able to communicate what a simple drawing looks like to another student.

2. They should also be able to follow the instructions of another student well enough to make a reasonable copy of the other student's drawing.

(A) Activity.

- Students are grouped in pairs in such a way they cannot see what the other member of the pair is doing, but that they can talk to each other in a low voice. They can sit opposite one another with a wall of books between them.

- Each student is given two pieces of squared paper.
- Students are requested to make a simple, non-pictorial drawing on the squared paper. They must know that the drawings can only be made of straight lines, and that the places where the lines begin and end must be on the intersection of the lines on the squared paper. The drawings must be fairly simple at first. Allow the students to work on their drawings for a short time, 5-6 minutes.
- Then one student of each pair is to be the 'communicator' and the other is to be the 'drawer'. Without looking at each others' designs, the communicator instructs the drawer in drawing what he/she has just drawn. The students can question each other about what they have done or what they mean.
- When the students have drawn the designs from their partner's instructions they can look at the results and compare this design with the original design.
- Then they can swap positions and go through the process again.
- When all the students are finished this activity, the teacher should begin a group discussion on what had happened, and what the students had noticed. They should be encouraged to discuss what methods they found useful and what words they used most often. Examples of methods used might be :

  . We numbered the points on the grid so we could talk about them (See first computer skills).

I pretended that I was driving a car and I told him where I turned..

Some words and phrases most used:

on the same line, next to, move forward, up, down, left, right, on the edge, square, larger, smaller, upside down, do that again....

(B) Activity.

- Students are once again grouped in pairs, and each student makes a straight line drawing on the squared paper, which the other student does not see. In this activity the 'drawer' now becomes the 'mover', i.e. this student must move according to the instructions of the communicator. Moving one step on the floor is equivalent to moving one square in the design.

- The communicator directs the mover as before, only this time he/she moves along the floor.

- A third student is required to trace the mover's path with chalk on the floor.

- When all instructions are given, the students compare the path traced by the mover to the original design.

- The students swap roles and they repeat the activity.

- Discussion could focus on whether it was more difficult to follow instructions by walking rather than drawing. The importance of clear instructions should be brought to the students' attention.

(C) Activity.

- The students will repeat the first exercise, but this time, no words are going to be allowed at all! They will be given a few minutes to decide how they are going to communicate with each other before they begin making the drawings.

- Then they draw, one student becomes the 'silent communicator' and the other the drawer. The students will perhaps find this activity difficult at first, but it will give them the experience of inventing a 'language' themselves and is different from previous activities in that no 'explaining' can go on during the communication process.

The discussion at the end of this activity should be led to focus on these important points:

i) A language allows us to communicate easily with others and to do useful things.

ii) We learn a language quickly when we know what we need to know.

LOGO ACTIVITY 2 : MEETING THE TURTLE.

Children first meet the turtle in the DOODLE mode. In DOODLE mode a minimum set of turtle commands can be entered by single keystrokes from the keyboard. Thus children who cannot yet read well or type reliably can use the Logo language and can learn how to think in that language

OBJECTIVES.

1. To give the children the opportunity to explore and have fun making their own designs.
2. To introduce them to the turtle; how it moves, and how to control its movements in direction and distance.
3. To show the students how to give titles to their designs, and then to show them how to run the procedure they have named.

EQUIPMENT.

A Radio Shack TRS-80 Color Computer and a Color Logo cartridge, and a keyboard overlay. A TV or computer monitor.

TIME.

A minimun of fifteen twenty-minute periods per student.

FORMAT.

Students working individually or in pairs.

TEACHER PREPARATION.

Load the Color Logo program into the computer before class. Place the keyboard overlay on the keyboard. Enter DOODLE mode by pressing BREAK, then typing R (for RUN), then pressing the @ key, and ENTER. An ≐ appears at the bottom of the screen, and the turtle is in the centre.

ACTIVITY.

– The students examine the small shape in the centre of the screen. The teacher explains that this is called a turtle and encourages the students to press some of the top ten keys. What happens? The students will observe that the turtle moved and drew a line on the screen as it moved. Discussion could take the following form :

"Does it look like a turtle? No – but like an ordinary turtle, the turtle on the screen can crawl forwards and backwards, it can turn right and left. Unlike an ordinary turtle, this turtle can drag its tail when it moves and leave a path. This turtle can even be made invisible. We can control the movements of our turtle by pressing these keys along the top. The turtle understands these commands – these keys are part of the language the turtle uses."

– The teacher allows the students to press these keys and experiment with making patterns. The keys command the turtle as follows :

(1) Clearscreen.

(2) Home - the turtle goes back to starting position.

(3) Penup - turtle does not leave a track when it moves.

(4) Pen down - turtle leaves a track.

(5) RT 45 - turtle turns 45 degrees to the right.

(6) LT 45 - 45 degrees to the left.

(7) FD 1 - turtle moves one 'turtle step' forward.

(8) FD 10 - moves ten 'steps'.

(9) RT 15 - turns fifteen degrees to the right.

(Ø) LT 15 - turns fifteen degrees to the left.

Point to emphasize: We use these keys to communicate with the turtle. We must use the language the turtle understands.

-Exercises 1 and 2 (at end of this chapter) give the students practice in manipulating the turtle using these keys.

- When the students have experimented with the command keys they can learn to name a procedure.

For a fresh start; go into BREAK mode by pressing BREAK; clear the procedure space by pressing SHIFT CLEAR; and then back to DOODLE by R, then @.

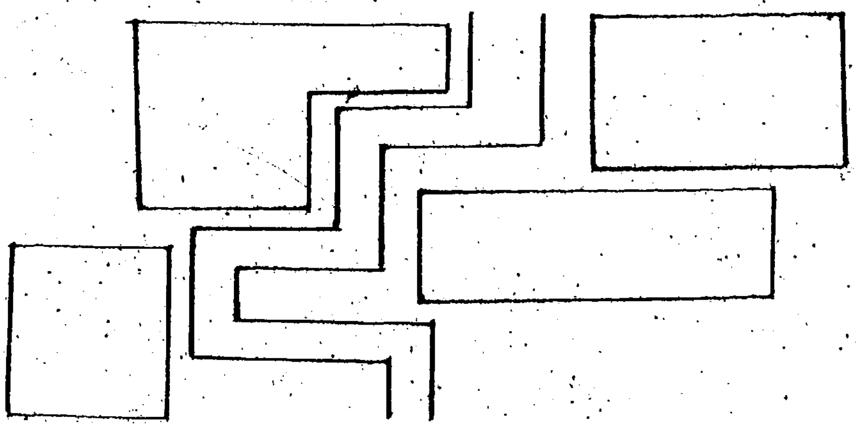
To create a procedure the students simply type the name that they want to use after the = sign. The name can be as simple as a single letter or number. After typing the name the students press ENTER, and then press the keys to control the turtle. Students can be creative in both inventing names and in carrying out the design. Communication between the students is to be encouraged. When the teacher has explained the methods to the students and observes that they understand what is required of them, he/she should try to stay in the background and act as a guide only when the students experience difficulty. Student self-exploration and self-learning is an important objective at this point.

- Students should now learn to run their procedure. The teacher shows them how to get into RUN mode (press BREAK, then R), and how to type in the title of the procedure and then ENTER. The students can now watch the turtle go through all the steps to execute their design. Through trial-and-error the students will discover that to run their procedure they must follow the steps in exact order, and that the title of the procedure must be remembered and typed in correctly.
- To further encourage their creativity, the students could compose a story about the turtle to accompany their procedure, and could tell it while their procedure is being run. For example : 'Tommy Turtle Builds a House' could accompany a procedure called HOUSE. New words and vocabulary work could be reinforced in this way.
- Students should be given plenty of time to practice the Logo skills they have learned to date.

When the students become adept at naming their program, drawing the design, and then running it in RUN mode, they will have mastered the first concepts of Logo, and, hopefull will have enjoyed the experience and be eager to learn more.

Exercise 1

The teacher could copy and enlarge a diagram of a maze like this one onto a transparent sheet. This sheet could then be hung in front of the screen with tape. The student tries to move the turtle through the maze.



Exercise 2. 'Dodge the Circles.'

Objectives:

1. To have fun manipulating the turtle.

2. To enable the students to practice controlling the turtle on the screen.

Directions.

Load this program into memory (EDIT mode: BREAK, E).

TO PLOT

```
REPEAT RANDOM 10+2(SX RANDOM 200 SY RANDOM 100+50
REPEAT 12(FD 5 RT 30))
END
```

Then run the program. (BREAK; R; PLOT, ENTER) A random number of circles will appear at random positions on the screen. The student is required to make the turtle loop around these circles without touching them. To do this get into DOODLE mode, type in a title after the = sign, and then ENTER. Now the student can give the commands to move the turtle. To see the actual path made by the turtle (without the circles), press BREAK, R; and then enter the title of the path.

To begin again, type CLEAR, Enter, and run PLOT again. A new set of circles will appear.

LOGO ACTIVITY 3 : DRAWING DEFINITE SHAPES.

OBJECTIVES.

1. To give the students further opportunities to develop their skill in directing the turtle in DOODLE mode.
2. To give them practice in making pre-defined shapes and designs.
3. To show them how to edit their procedures.
4. To teach them to look carefully at their procedures and to relate the symbol commands with the turtle's movements.

FORMAT, EQUIPMENT and TEACHER PREPARATION as for Activity 2.

TIME.

Ten twenty-minute periods per student (minimum).

ACTIVITY.

1. Begin by revising Activity 2 : Naming, drawing and running a procedure in DOODLE mode.
2. Now the teacher gives the students more definite directions for the procedures :

"Call your program 'LINE' and make the turtle walk a straight line up the centre of the screen;

.... a straight line in this direction...down the screen; etc.

... a long thin line in this direction;

... a short thin line;

... a long wide line, a short wide line..."

As the student works on each procedure giving one command at a time and watching the result before giving the next command, he/she may wish to remove the last command. The student will learn that to take away that command he/she will have to remove the symbol that was typed for that command. Students should equate the symbols with certain turtle actions. To remove that last command the students will be introduced to the delete key in DOODLE, the back-arrow key. This will give them even more control over their own procedures and requires them to make decisions :

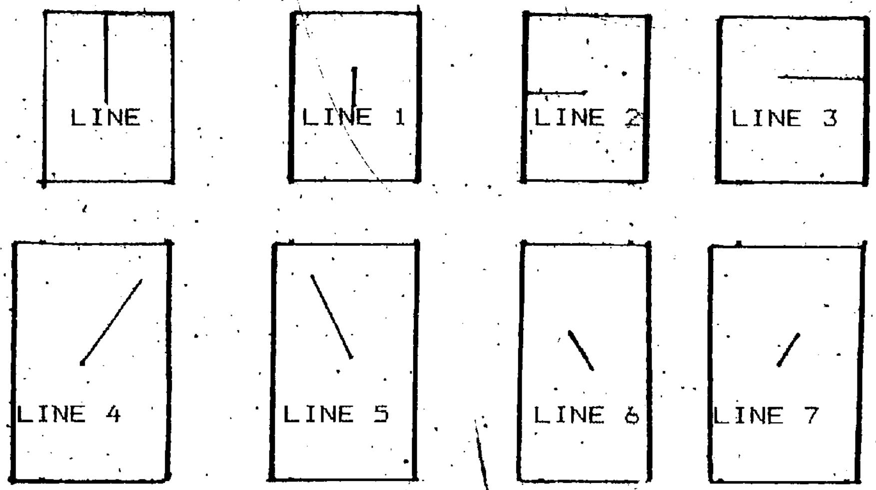
"Is that the command I want the turtle to obey?

Is the turtle facing in the right direction?

Is that line too long or long enough?..."

When the children are satisfied with their procedure they can run it and begin another, giving it a different title.

3. A set of work cards would enable the students to work independently and at their own pace. IN the type of work card suggested here, the students select a card, type in the name of the program that is given on the card, and try to copy the designs.



At the end of the session the teacher could check each student's progress by looking at the procedure area in EDIT mode and running the programs in RUN mode.

4. The student is given more complex directions :
'Draw a box; a small box; a big box; a long box...'
Before giving the turtle the commands for the first box, the teacher encourages the child to play at being the turtle himself/herself on the floor, and to take the steps the turtle would take to make the box. While moving, the child should say what he/she is doing. "Four steps up this way, turn and face to the right..." Then the students can apply what they learned from moving themselves to moving the turtle on the screen.
- A set of workcards would work here also. However the student need not be concerned about copying the example exactly, a rough copy will be very acceptable from beginners.
- Other designs might include a rectangle, triangle, circle, house, boat, man, sun, tree, etc. Designs could reinforce

material learned in mathematics, reading and spelling, environmental studies and other curricular areas. The complexity of the designs will depend upon the ability of the student.

LOGO ACTIVITY 4 : CHANGING the PROGRAM.

OBJECTIVES.

1. To show the students how to add to, and delete from their designs.
2. To allow them to become capable of entering EDIT mode and editing their procedures.

FORMAT and EQUIPMENT as for previous Activities.

TIME.

As long as it takes for the students to gain adequate experience and to work comfortably in EDIT, RUN and DOODLE modes.

ACTIVITY.

- The students were shown how to edit their programs in DOODLE by deleting the last command. Another type of editing the student may wish to do is to add on to the end of a previous procedure. To do this the student will run the current version of the program in RUN mode. The shape will be drawn on the screen. The student will be shown to go into DOODLE mode (@) and give a second name. The student's attention should be drawn to the present position of the turtle - it is at the home position instead of at the end of the shape. The student begins the new procedure with HOME (key 2), raises the pen (key 3), moves to the end of the shape, and lowers the pen (key 4). Now the student can proceed with completing the shape.

- To run the whole shape:

The student can run the two procedures in sequence or can enter EDIT mode (BREAK, then E) and find the two procedures. Then the student deletes the title and all the turtle commands from HOME to PENDOWN at the start of the second procedure. This requires the student to learn the delete commands in EDIT, as well as to recognise the turtle commands for HOME and PENDOWN in symbol form. When the student has finished editing he/she can run this procedure (BREAK, then R). Further editing or additions can be made until the student is satisfied with the end product.

The students will need plenty of practice to become familiar with this activity as many new keys and commands are encountered for the first time. Activity 6 could be done parallel to this activity as it gives the students more practice in working in EDIT mode.

ACTIVITY 5 : SAVING and LOADING LOGO PROGRAMS on TAPE.

OBJECTIVES.

1. To show the students how to save their programs on tape, and how to load their programs from tape into the computer.
2. To show them the correct ways to use and look after a tape recorder and tapes.
3. To give them first hand experience of an important computer input and output device.

EQUIPMENT : Microcomputer, VDU and COLOR LOGO as before. A compatible tape recorder and blank tapes.

ACTIVITY

- Students now have some experience of writing and editing their procedures. Their procedures are important to them and for this reason they may dislike losing them when they turn the computer off. Most students will welcome the tape recorder as they will be able to save their good procedures, and it will enable them to do more work on other unfinished ones. Learning to save their procedures on tape is very simple, so simple that even young children should experience little difficulty after some guidance.

- The students will be aware of the tape recorder and its function (First computer skills), but saving their own work may be a new experience for them. When a student has finished working on the computer, the teacher should ask if he/she would like to save the procedures that are in memory and work with them at another time. If the student wishes to save his/her work, the teacher can demonstrate how to connect the tape recorder correctly and insert a blank tape.

- To save procedures on tape the computer must be in BREAK mode. The student could go into EDIT and delete any procedures that he/she does not want to save. Then the student gets into BREAK mode and presses S. The prompt will be LOGO: SAVE: -. The student rewinds the tape (Rewind, Stop) and then presses the RECORD and PLAY buttons on the tape recorder down together. The volume setting should be at about half the maximum volume. Now the student is ready to record. The student responds with T and ENTER to the SAVE prompt on the computer.

When the recording is finished, the BREAK mode prompt will appear on the screen. But if a number and a question mark appear after the T, then the procedures were not saved properly, so the student should try again.

- Learning to load programs from tape is also simple. The tape will have to be rewound amd the PLAY button depressed. Again the student should be in BREAK mode and must press L. The prompt will appear on the screen, LOGO : LOAD :- The student types in T and presses ENTER to start the process. Then the student can get into EDIT and look at the procedures that have been loaded from tape.

- A set of instructions telling how to Load and Save could perhaps be posted near the computer until all the students are familiar with the process.

- Each student could begin to build up their own file of programs on tape. This would enable the student to review previous work and allowthe teacher to observe each child's progress.

- Students should also learn how to handle the tapes and the tape recorder carefully.

LOGO ACTIVITY 6 : WRITING WITH LOGO.

This section can be taught in conjunction with ACTIVITY 4 as it requires the student to become familiar with all the edit commands. This section however, reinforces the edit commands through writing. It is 'non-turtle' Logo. The students are required to have acquired some skill in reading and writing in order to benefit from this simple wordprocessing. Familiarity with the keyboard would also give the children an advantage. (First computer skills)

FORMAT.

Students work individually or in pairs.

EQUIPMENT.

Computer, VDU, Logo cartridge, printer and paper.

TIME.

There can be no recommended time limit for this activity as it is an ongoing activity. The teacher will see many ways to expand on the suggested activities. It can be incorporated into many reading and writing activities throughout the school day. Children should be given adequate time to gain confidence and skill, and this will vary according to the abilities and interests of the students.

OBJECTIVES.

1. To teach the students some simple wordprocessing skills.
2. To encourage them to be creative and accurate in their writing.
3. To develop their reading and writing skills.
4. To show them that the computer has many purposes.

ACTIVITY.

- The computer is in EDIT mode. Children are asked to locate the turtle on the screen. It is not there. "We can do other things with the computer as well as commanding the turtle to move. We can use the computer to write messages, and to correct any errors we make when we write."

- Students are introduced to the cursor - a short horizontal line at the bottom of the screen. The cursor shows where any typed letters, numbers, etc., will appear.

- Students begin by typing in a very short sentence, e.g. 'I am six years old.' Then ENTER. ENTER moves the cursor to the start of the next line. Repeat this until the student can do it easily.

- Students write a short note, a few lines long. To stop editing they press BREAK. To alter the note they must return to EDIT (press E) and the first line of the note appears with the cursor at the start of the line. To change a letter the student must position the cursor under that letter. The cursor is moved by the arrow keys. Up-arrow (↑) and down-arrow (↓) change lines, and left-arrow (←) and right-arrow (→) move the cursor within a line. When the cursor is in place the student can replace the letter or word by overtyping. If the student needs more space for another letter he/she holds down the SHIFT key and presses the right-arrow key for every space needed. If the student wants to delete a letter or space he/she holds down SHIFT and presses the left-arrow key.

The students should get plenty of practice in using these keys. Typing in messages, stories or poems, and then editing them will foster these skills.

- Other features likely to prove useful to the student in editing text is the ability to insert lines (cursor at beginning of the following line, press SHIFT and down-arrow), to break a line in two (cursor where you want the break, SHIFT and down-arrow), and to scan the text (SHIFT and up-arrow). To interrupt the scan, just press any key; to restart the scan press SHIFT and up-arrow. To jump back to the start of the text press CLEAR.

- A chart showing all the editing commands could be hung near the computer where the students could consult it quickly and easily.

- Students could use the wordprocessing features of Logo to write class assignments. If such assignments were lengthy students might perhaps save their work on tape, reload it at a later date and continue writing or editing.

- The students' writing takes on a new meaning for them when they can produce neat correct printed text. Their wordprocessing skills will be enhanced when they are given the opportunity to have their work printed. They should have little difficulty in learning how to use the printer. Simply connect the printer correctly, load the paper and turn it on. The computer should be in BREAK mode. Enter P for single space printing, or Q for double space and the text in memory will be printed. Students may have their writing typed first in single space, and then in double in order to compare them and to decide which for is most suited to their needs.

- Students' printed work should be displayed around the classroom.

LOGO ACTIVITY 7 : INTRODUCTION TO TURTLE GEOMETRY.

OBJECTIVES.

1. Students will be introduced to the Logo commands : Forward, Right.

2. Students will experiment with these commands to create their own designs.

3. They will become familiar with turtle units of length - 'turtle steps', and size of angles - 'turtle turns', through exploration.

EQUIPMENT.

TRS 80 Color Computer loaded with Color Løgo.

Cards with Logo commands.

Cardboard turtle, overhead projector.

Logo worksheet 1 and 2.

ACTIVITY.

1. A suitable introduction would be for the teacher to make up a story about a turtle; and tell it using a cardboard turtle which is moved around on the chalkboard, or a clear plastic one that could be moved around on the overhead projector. The students need to understand that this 'turtle' understands certain words and commands and that the teacher is now going to introduce some of these words. Teacher poses the question :

"What will the turtle do if it gets these commands?"

FORWARD 10
RIGHT 90
FORWARD 10
RIGHT 90
FORWARD 10
RIGHT 90
FORWARD 10
RIGHT 90

There are some things the students have no way of knowing: How far will the turtle go forward? How far right will the turtle turn, and in what direction will the turtle start? They are also unaware that the values in some commands (FORWARD) refer to distance, while other values (e.g. RIGHT 90) refer to angle size or 'turtle turns'.

The students are encouraged to find these answers for themselves by giving these commands to the computer. The teacher should display cards showing the command in a prominent place so that students can type it in correctly.

Points to emphasise : The computer must be in RUN mode (BREAK, then R).

. There must be a space between FORWARD and 10. Students can use the left-arrow key to correct typing errors before they press ENTER and then simply backspace to the beginning of the error and retype the turtle instrucion. Or just press ENTER and re-enter the line correctly.

2. When they have entered and observed the previous program they are now free to experiment as they wish with these commands, giving different values for distance and angles. Some guidelines for them might be to compare the differences in : FORWARD 1

FORWARD 10

FORWARD 50

'In FORWARD 10 what does '10' mean? It could be described as the length of the turtle track or the number of turtle steps'. If the students give a large value, like FORWARD 100 , they will observe that the turtle moved, but it did not leave a track. The number of turtle steps was so great that the turtle left the top of the screen. When the turtle goes off the top of the screen it comes back at the bottom. This is called 'wrapping around'. The turtle can wrap around only by lifting up its tail, so no track appears for any steps where the turtle wraps around.

3. Students can experiment with the angle size as well as with distance. No attempt should be made to explain degrees to the student as he/she will learn by experimenting.

4. Teach the abbreviations for the commands :

FD = FORWARD

RT = RIGHT.

5. Students should be given plenty of opportunity to experiment with these commands, making their own designs, and working at

their own pace.

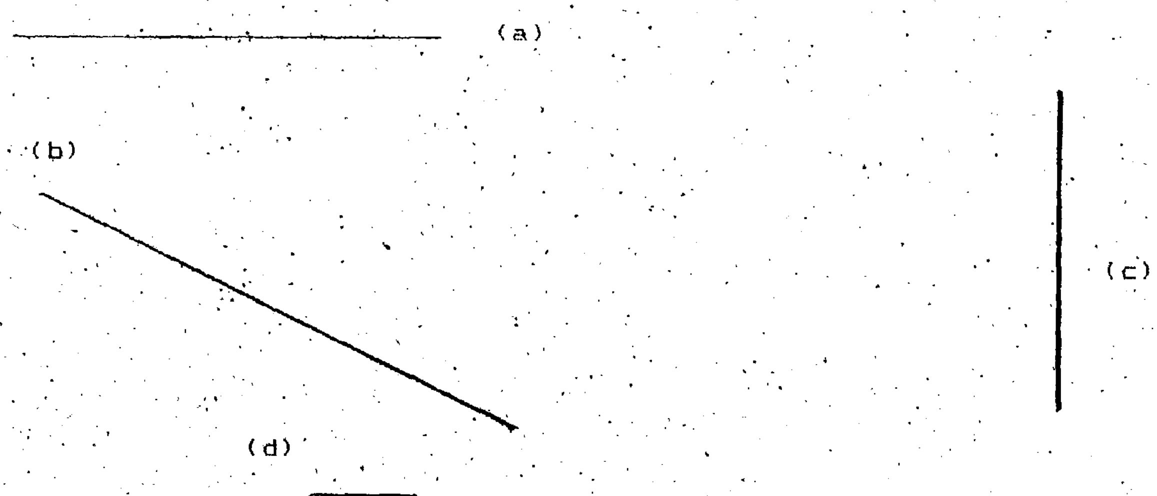
6. Those who have mastered the concepts so far could now be given Worksheets 1 and 2. It is not necessary for every student to use the worksheets, some students will need much more practice and experience with Logo before they can tackle them successfully. Accuracy is not a very important factor in the worksheets. Estimating, which shows an understanding of the concepts is what is required.

WORKSHEET 1.

NAME :-----------------------

1. If it took a turtle 100 steps to make this line

how many steps did it take to make these lines?



2. Draw a line which you think will be

(e) 150

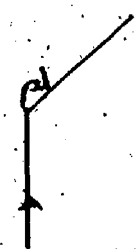
(f) 90

(g) 50.

WORKSHEET 2.

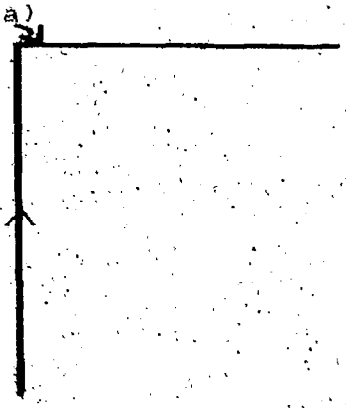
NAME : -------------------

1. If the turtle turned RIGHT 40 to make this corner

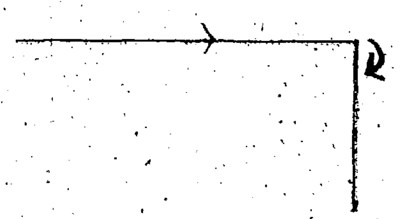


how far did he turn to make these?

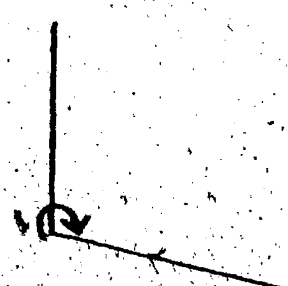
(a)



(b)



(c)



LOGO ACTIVITY 8 : MORE LOGO COMMANDS : BACK, LEFT and CLEAR.

OBJECTIVES.

1. The students will learn the Logo commands BACK, LEFT and CLEAR.

2. Students will experiment with these commands to create their own designs.

3. Students will combine these commands with those learned previously to create shapes on the computer.

EQUIPMENT.

As for Activity 7, and Worksheets 3, 4 and 5.

ACTIVITY.

1. Begin by revising the previous commands.

2. Introduce the commands BACK and LEFT using a method similar to that used for FORWARD and RIGHT.

- Give the students plenty of time to experiment with these commands and to discover that the measure of distance in BACK is the same as that in FORWARD, and that measurement of angles, or corners, or turtle turns is the same in RIGHT and LEFT.

3. Teach the abbreviations BK and LT.

4. Teach the command CLEAR and show them that entering this word (not the single key) will clear the screen and make it ready for a fresh start.

5. Encourage the students to give the turtle a series of instructions using all the commands learned so far.

6. Worksheet 3 : Students can solve the problems using paper and pencil, commanding the turtle and examining the end result on the computer, or (and preferably) using a combination of these methods.

7. Worksheet 4 : This gives the students practice in planning a path and in giving the instructions needed to make that path. This worksheet can be done at two levels of difficulty:

(a) The student describes the path taken in general terms, e.g. 'Go straight for two blocks, turn right....".

(b) The student can give directions in 'turtle terms', where each square on the paper is equal to 10 turtle steps, and each corner angle is 90.

8. Workcard 5 : This workcard gives the children practice in estimating, predicting and planning, important skills in Logo.

WORKSHEET 3.

NAME : ----------------------

Here is a list of instructions for the turtle. Can you give the turtle just one command that would be the same as the list?

EXAMPLE :

FD 20, BK 10, FD 20----------→ FD 30

(a) FD 30, FD 40, FD 30 ---------→

(b) FD 60, FD 80 ---------→

(c) FD 80, BK 20, FD 30 ---------→

(d) FD 50, BK 40, FD 50, BK 40, FD 40 --→

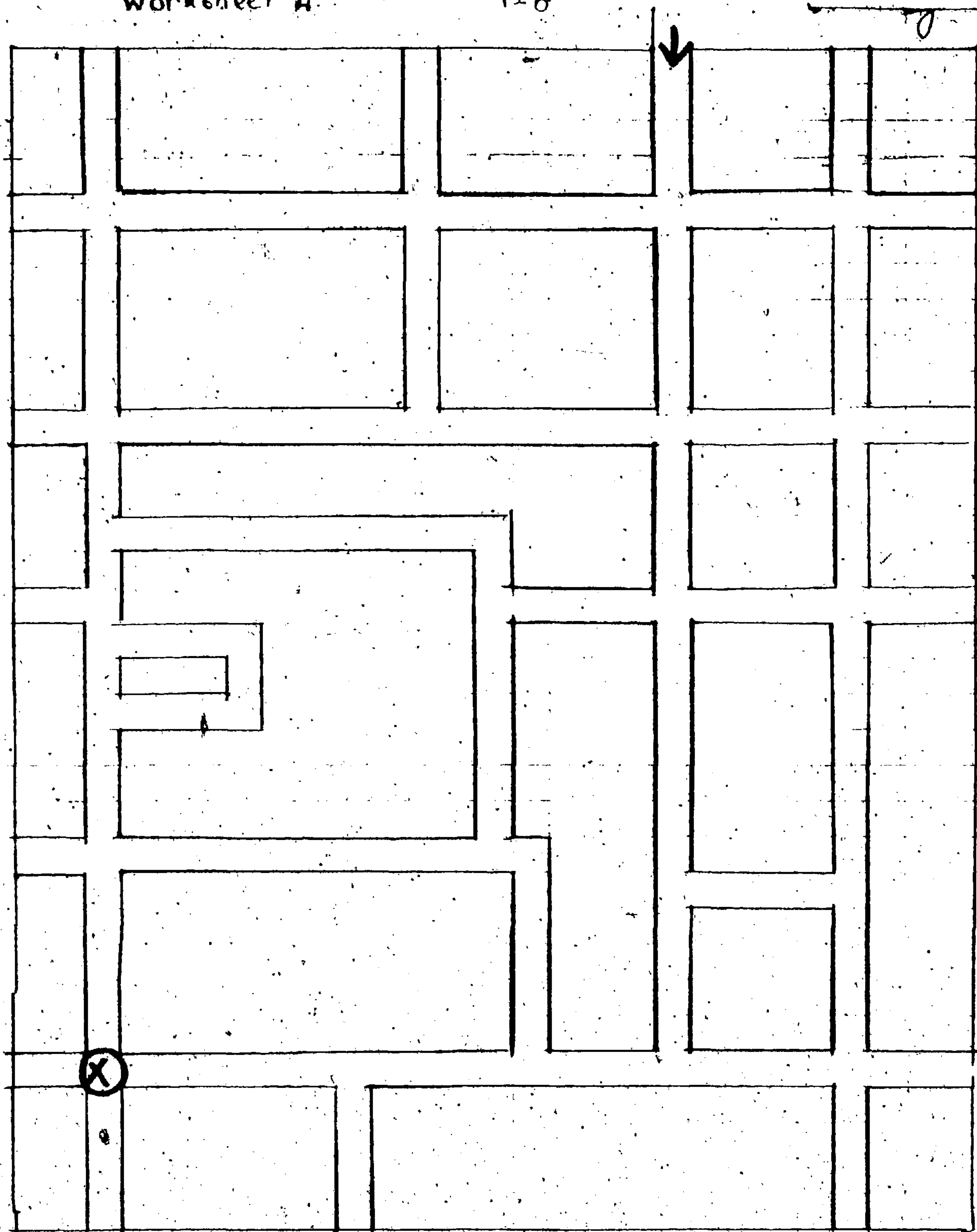
(e) RT 20, RT 40, RT 25 ---------→

(f) LT 10, LT 40, LT 54 ---------→

(g) RT 100, LT 70, RT 60 ---------→

(h) LT 40, RT 75, LT 35 ---------→

Worksheet 4 127



1. Start at the arrow and go to the ⊗ Draw a line along your path.
2. Describe your path saying how many block you go before turning, and which way to turn and how to go on from there.
3. Describe your path in turtle language. Each ⟼ is equal to 10 turtle steps, and each corner L is 90.

WORKSHEET 5.

NAME : ------------------

1. Tilly and the Rock.

One day Tilly Turtle was out for a walk. But there was a rock in Tilly's way. Here is how Tilly moved :

RT 90

FD 20

RT 90 The Rock.

FD 20 X

LT 90

FD 20 Tilly Turtle

LT 90

FD 20

RT 90

FD 20

(a) Draw the path that Tilly took.

(b) Give the computer the instructions and look at the path. Is it the same as yours?

2. Tommy's Triangles.

Tommy Turtle loves triangles. He is also very lazy. Here is how Tommy made two triangles with very little effort.

```
FD 30
RT 120
FD 30
RT 120
FD 30          Tommy starts here.
RT 60
FD 30
RT 120
FD 30
```

Can you draw Tommy's triangles?

Have Tommy draw them on the computer.

3. Your Initial in Turtle Steps.

Draw your first initial here using only straight lines.

Write instructions for the turtle to make that letter.

INITIAL INSTRUCTIONS.

Now give the instructions to the computer. Does the turtle make your initial correctly?

5. MORE TRIANGLES.

Can you think of a way to have Tommy Turtle draw three triangles with only a few more instructions?

ACTIVITY 9 : PROCEDURES.

OBJECTIVES.

1. The students will be able to combine the commands learned so far into units called procedures.
2. The students will understand procedures both by using them and constructing them.

ACTIVITY.

- The students make the turtle draw something by giving a series of commands. Then they think of a name for the picture (for Example, HOUSE). In order for the turtle to draw this picture again we need to teach this name to the computer. This can be done by creating a procedure. But first the student must write down the commands to make the picture, or remember them. The steps to be learned to create a procedure are as follows :

(1) Get into EDIT mode (BREAK, then E).

(2) The first line of the procedure contains the name. We use the word 'TO' to tell the computer that we are naming a procedure. After 'TO' we type in the name :

TO HOUSE

(space)

Then ENTER.

(3) Next we type in all the commands to the turtle to draw the HOUSE :

```
TO HOUSE
 FD 50
 RT 45   .....etc.
```

(4) To end off the procedure we type END on a new line and then ENTER.

To try out the HOUSE procedure we must go into RUN mode (BREAK, R), and enter the name of the procedure. The turtle goes through all the steps to make HOUSE. The procedure HOUSE is now in the computer's memory, and the turtle understands the word 'HOUSE'.

If the students want to change the procedure they can edit it in EDIT mode. (Revise editing)

- Students should be given plenty of practice in creating procedures, running them, debugging them, etc. They can save their best procedures on tape and use them again.

- Students can experiment as to the best structure for writing the commands in a procedure, e.g.

```
TO M                    TO M
 FD 30                   FD 30 LT 45 FD 20 RT 45
 LT 45                   FD 20 LT 45 FD 30
 FD 20                  END
 RT 45
 FD 20
 LT 45                  TO M
 FD 30                   FD 30 LT 45  END
 END
```

.....cont.

```
FD 20 RT 45
FD 20 LT 45
FD 30
END
```

Which is easier to follow; easier to change; takes less space?.....

Students can decide which structure they would prefer to use.

LOGO ACTIVITY 10 : MORE TURTLE COMMANDS.

OBJECTIVES.

1. To introduce the students to the commands :

PENUP PENDOWN

HIDETURTLE SHOWTURTLE.

2. To give them an understanding of these commands through repeated and creative use.

ACTIVITY.

1. To The Student :

"Try this - Clear the screen (CLEAR) and make the turtle move back 40 steps (BK 40). Where is the turtle now? He is on the line. In fact he is covering up some of the line, but we can see through him. Wouldn't it be better if the turtle was invisible? Then we could see the line more clearly. To make him invisible or to hide him we can use the command

HIDETURTLE or HT.

Even though the turtle is invisible he still makes a track. Try this :

CLEAR

HT

BK 50

We can see the track the turtle made but we cannot see the turtle. To make the turtle appear again we use

SHOWTURTLE or ST:

Try it and see. Now write some procedures of your own using HT and ST. Perhaps you could save the best one on tape."

2. "The turtle can also move without making a track. We can command him to raise his tail when we don't want him to leave a track, and to lower it when we want him to make a track. Can you guess what commands we would give to do this? The commands are :

PENUP or PU for no track, and

PENDOWN or PD to leave a track.

Try these new commands on the computer; write a procedure and run it.

- Write instructions to draw

a) your initials,

b) your first name. To do this you will need to have the turtle stop drawing while you move between letters. Use PENUP and PENDOWN.

- Draw these pictures on the screen together. Use HT, ST, PU, and PD; RT, LT, FD, BK and CLEAR. Write down the instructions as you give them. Then use them in a procedure 'TWO' to draw the pictures again."

3. To the Teacher.

Accuracy in drawing is not important in these ativities. Rather, their purpose is to reinforce an understanding of the commands and to encourage problem-solving, creativity and planning in the student. A suggestion would be for the teacher to write down the commands as the student debugs them, and to read them to the student as he/she is writing the procedure. Or the students could copy down all their own commands as each command is successful. Then the students could run the procedure to see if there are any more bugs. The kinds of debugging situations encountered will vary according to each student, and the teacher should be ready to intervene if the situation becomes too difficult for the student.

- Some procedure suggestions :
  - skyscrapers
  - rockets
  - a fabric pattern .....

LOGO ACTIVITY 11 : NEW POSITIONS FOR THE TURTLE.

OBJECTIVES.

1. To introduce the students to the commands for changing the position or direction of the turtle on the screen. The commands are :

SETX	or	SX
SETY	or	SY
HOME	and	
SETHEADING	or	SH

ACTIVITY.

1. In our designs the turtle begins to move from a position in the centre of the screen. This position is called HOME. If we want the turtle to begin from a different position we use the commands :

SETX or SX , and

SETY or SY .

For example :

```
TO BOX
 SETX 60
 FD 50 RT 90
 FD 40 RT 90
 FD 50 RT 90
```

....cont

FD 40

END

The turtle moves to the position we have named regardless of where it was before this. No line or track is drawn as it moves to the position, and the turtle still points in the same direction as it pointed before it moved. Students should experiment with different values for these commands, and insert these commands into other procedures and observe how they will effect the design of the procedure when it is run.

2. To send the turtle back to the original starting position in the centre of the screen we use

HOME.

3. To point the turtle in a certain direction we use

SETHEADING or SH

For example : SH 90

The value of the direction can be any number from 0 to 359. When the turtle gets this instruction it points in the given direction regardless of where it was pointing previously.

4. Students are requested to create a design and write a procedure with the following guidelines :

a) Using the command SX;

b) Using the command SY;

c) Using the commands SX and SY;

d) Using the command HOME;

e) Using the command SH;

f) Using as many of these new commands in one procedure as you can, e.g. — a design that has a triangle in each of the four corners of the screen.

LOGO ACTIVITY 12 : BUGS and MORE BUGS.

The students have acquired an extensive Logo vocabulary, and can now communicate effectively with the turtle. So far, the emphasis has been on exploration and imagination to understand the new commands and to apply them. The students were free to design their own programs using the given commands. In this section there is a slight change of approach in that the student is expected to follow specific instructions in designing a program. The students might be required to draw a certain shape, to copy a diagram, or to use certain commands in a special way. All these require the student to think more carefully about what he/she is doing. The students will encounter 'bugs' in their attempts to follow instructions, and it is through correcting these that the student engages in such activities as estimating, calculating, predicting, planning, thinking and learning. The students will apply what they learned by discovery and by trial-and -error. They could also refer to features used in previous procedures as a source of information. It is almost impossible to list the benefits of working in such a learning environment as Logo. However, some of the objectives for this exercise are :

1. Students will learn to draw upon their Logo vocabulary to follow as best they can the instructions that they are given.
2. Students will learn to look upon an error or bug as a

challenge, and will seek to debug it in an intelligent way, and so develop good problem solving skills.

ACTIVITY.

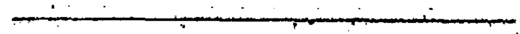
For the Student:

- 'Write procedures to draw the following designs. You can experiment first. If you have a bug in your program see if you can solve it. If it is too difficult ask a friend, or maybe your teacher. Good luck!'

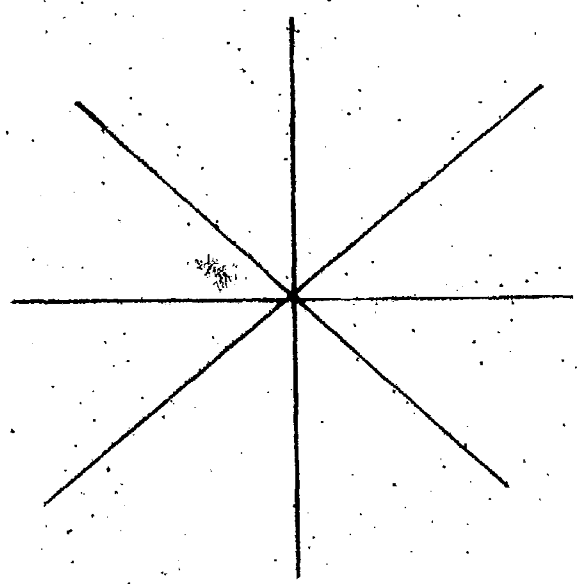
For the Teacher :

- The teacher should be able to judge the capabilities of each student and so assign activities based on the student's ability. Logo offers many opportunities for flexibility so that the learning needs of every student can be met. There is no specific order in which the students could work through the designs, and each student will differ in the length of time it takes to grasp all the concepts. A flexible, imaginative, and helpful approach is possibly the best way for the teacher to act as a guide in helping the students learn with Logo.

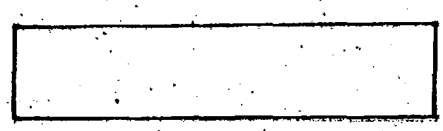
2. Line



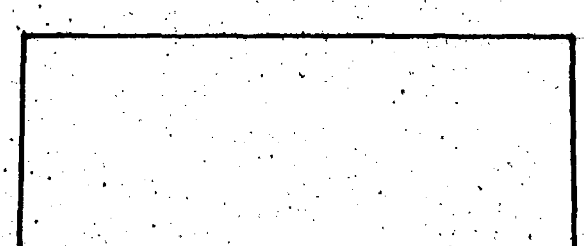
3. STAR



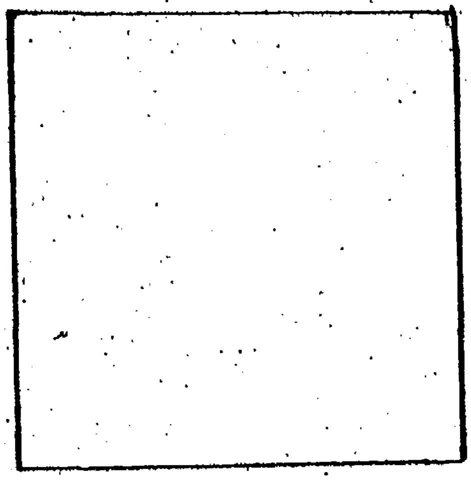
4. RECTANGLE



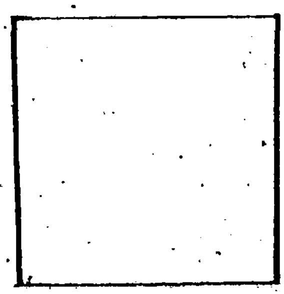
5. RECTANGLE 2.



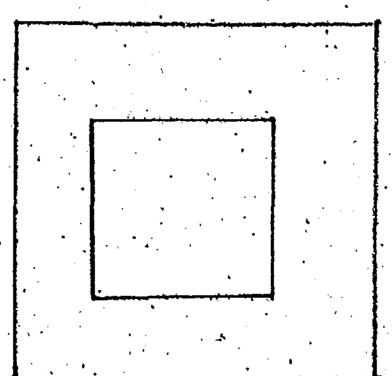
6. Square



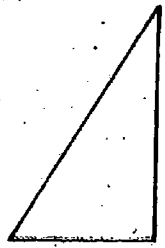
7. S Square



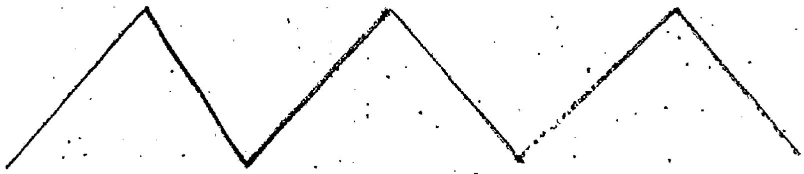
8. T Square



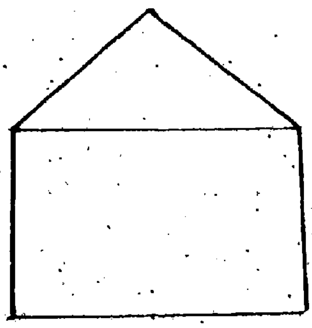
9 Triangle



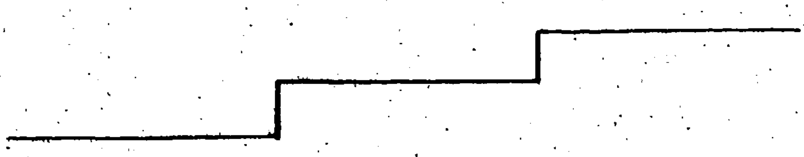
10 ZigZag



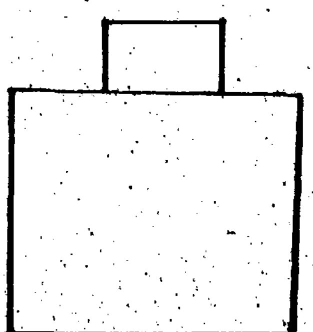
11 House



12. Steps



13 Boxes



etc.

LOGO ACTIVITY 13 : COLOR LOGO.

OBJECTIVES.

1. The students will learn the commands to change the color of the screen and the color of the turtle tracks.
2. Students will be able to experiment with the different colors to make their designs more colorful and fun.

EQUIPMENT.

It is necessary to have a color monitor or a color TV set. Computer and Color Logo as before. If a black-and -white TV is the usual classroom equipment, perhaps a color set could be borrowed for a short period of time to give the students an opportunity to learn a little more about the computer, and also to allow them to enhance their designs.

ACTIVITY.

- Students are asked to comment on the color of their screens and on the color of the lines.

"Do you like the color? Is the contrast between background and lines good? Why do we need a good contrast?...

The turtle can draw colored lines and we can change the color of those lines if we want to. We have a choice of two sets of colors - COLORSET Ø or 1. So far we have been working in

COLORSET Ø. There are four colors for each set. These colors are numbered Ø,1,2 and 3. To change to a different color set we use

COLORSET 1 or COLORSET Ø .

Students can experiment with these commands. For exmple, they could run a procedure (in RUN node) and then change the color set.

HOUSE

COLORSET 1 and then back to

COLORSET Ø. Which is clearer? Why?"

In each color set the normal background color is 3 and the normal drawing color is color Ø. Students can easily change the drawing (or pen) color by giving the command

PENCOLOR or PC

e.g. In the procedure BOX they could have

```
TO BOX
 PC 2 FD 50 RT 90 FD 40 RT 90
 PC 1 FD 50 RT 90 FD 40
```

- To change the background color students use the command

BACKGROUND or BG followed by the number of the color they wish to use. For example,

```
TO BOX
 PC 1 BG 2 FD 50 RT 90 FD 40 RT 90
 FD 50 RT 90 FD 40
```

- Students can introduce many color variations to their procedures. By experimenting, they will discover which colors look best together, and which add to their designs. The colors can be improved by adjusting the color and tint controls on the TV or monitor.

- Some points for discussion :

"What happens if the color of the pen and the color of the background are close together in number, e.g.

PC 1 BG 2 ?"

- Through exploration they may discover that an unwanted portion of a design could be erased by having the pen color of the unwanted part set to the same color as the background color.

- Use of color commands should be encouraged as it develops an awareness of color and contrast in the children, adds excitement to their designs, and allows for an expression of individality and creativity in the students' programming.

ACTIVITY 14 : SOME LOGO SHORTCUTS.

OBJECTIVES.

1. The students will understand and use subprocededures in their programs.

2. The students will understand and use the REPEAT command.

ACTIVITY.

(A) Begin by requesting students to review the procedure they wrote to draw a square, and to run it.
"What name did you give the procedure?" Review the idea that naming a procedure, e.g. SQUARE, is like teaching the turtle a new word. To run that procedure we simply type in the name and the turtle will know what to draw.

(B)
```
TO SQUARE
   FD 50 RT 90
   FD 50 RT 90
   FD 50 RT 90
   FD 50
END
```

Encourage the students to type in SQUARE, ENTER once, twice, three times, four times. What do they have now? Invent a name for this four-square design, e.g. FSQUARE. Teacher could write this name on the chalkboard and the class could review the process of how they created this design, e.g.

"It is made up of four SQUAREs.

WE told the turtle to draw one SQUARE after the other until we had our design. We typed in SQUARE, SQUARE, SQUARE and SQUARE."

Teacher should elicit ideas from the students as to a way to simplify this process. "How about teaching the turtle one word for this design. It would be easier to type 'FSQUARE" than to type SQUARE four times. To teach the turtle this word we must write a procedure FSQUARE.

```
TO FSQUARE        (ENTER)
```

What comes next? The commands. Is there an easier way than writing FD 50 RT 90...etc., as this way would be long and it would be easy to make a mistake. How could we break this procedure into simple steps? What four steps did the turtle make to draw this? The turtle drew four squares. Since the turtle already knows how to SQUARE we could write :

```
TO FSQUARE
  SQUARE
  SQUARE
  SQUARE
  SQUARE
END
```

Students should write this new procedure in EDIT mode and run it. (SQUARE must already be in memory.)

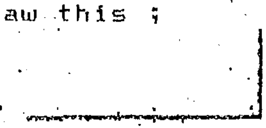
"Is it the same design as we had before? Which method is easier?...."

Using procedures to write procedures is a good way to work in

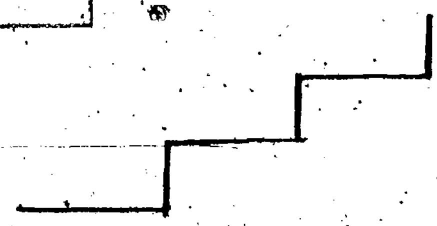
Logo. We can break down large tasks into a number of smaller, simpler ones. We make the task easier to do, and we make less mistakes. If we want to change our program we might only have to change one of the smaller parts. Our program is also neater, and easier to read and understand.'

– Some activities.

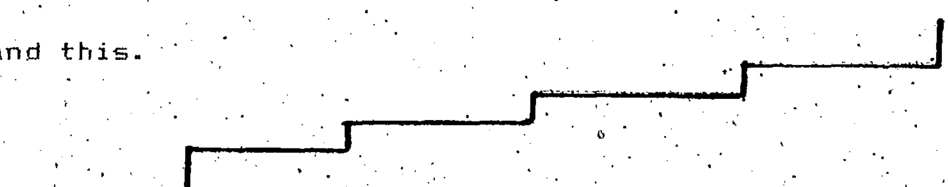
1. Write a procedure to draw this ;



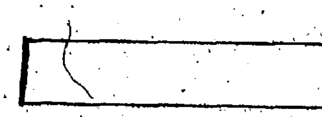
Now write a procedure to draw this;



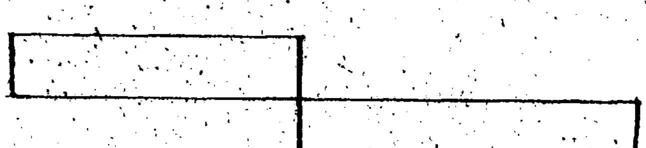
and this.



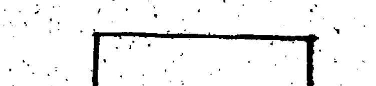
2. Write a procedure to draw this :



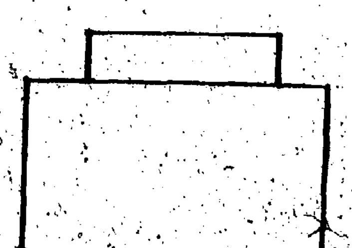
then this :



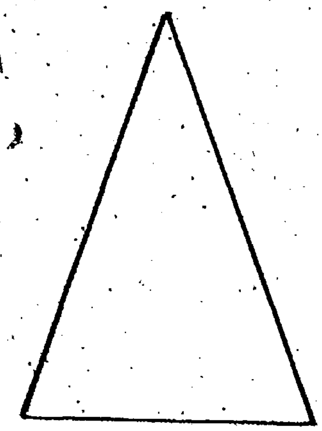
3. Draw this hat



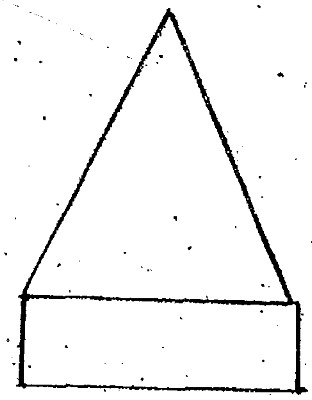
Now this :



4. Try this,



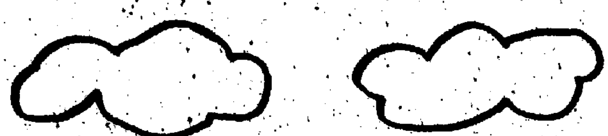
and this



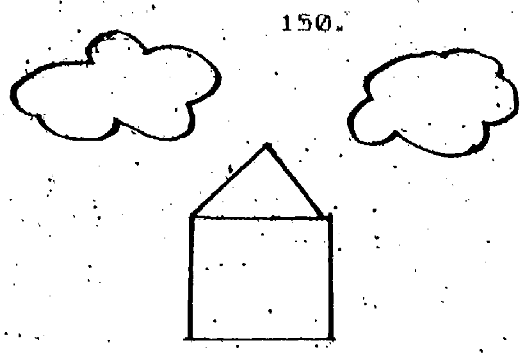
As the programs increase in complexity it becomes necessary to make some changes or add to the existing subprocedures. Students will discover this through experimenting by themselves.

Students can also combine procedures drawn in DOODLE mode with those written in EDIT mode. Some revision of DOODLE mode might be worhtwhile.

5. Get into DOODLE and draw some CLOUDS and run it (RUN mode).



Now get the turtle to draw this PICTURE :



Perhaps you could add a TREE, or a GATE. What is your picture like now?

Students will learn that they can use many different subprocedures to create a large program. The students will invent many different designs and will develop skills in modular programming.

(C) Students' attention is again drawn to the program SQUARE and then FSQUARE :

```
TO FSQUARE
   SQUARE
   SQUARE
   SQUARE
   SQUARE
END
```

There is a shorter way to write FSQUARE and to get the same result. Can you guess how to do it? By using the command REPEAT we can write

```
TO FSQUARE
   REPEAT 4 (SQUARE)
END
```

Students are required to erase the old FSQUARE procedure and to write the new one, and to run it. They will observe that the end result is the same.

The REPEAT command tells the turtle to repeat whatever is enclosed ( ) the number of times indicated. Commands and subprocedure names can be included in the parentheses. Students should try this program:

```
TO TSQUARE
 REPEAT 10 (SQUARE RT 40)
END
```

In this program the turtle draws the first square as before, and then turns 40 degrees to the right before drawing the next square. As the program says, this is repeated 10 times. Students will learn that the number of repetitions, and extra commands in parentheses will greatly influence the resulting pattern. They can experiment with these commands to create some spectacular designs.

LOGO ACTIVITY 15 : CIRCLES, CURVES and VARIABLES.

OBJECTIVES.

1. The students will learn how to draw curved shapes, through exploration, in DOODLE mode.

2. Students will learn how to draw circles by giving commands to the turtle in RUN mode. They will learn first through experimentation, then by following an outline, and then by using the pre-written program designed to encourage them to see the relationship between the number of sides in a shape and the size of the angles.

3. Students will make patterns using circles, arcs, and the REPEAT command.

4. Students will understand and use variables in their procedures.

5. Students will combine all they have learned in Logo to create a MASTERPIECE.

ADDITIONAL EQUIPMENT.

The programs CIRCLES, BOX, SHAPES, DESIGN, ROUND and MORE recorded on tape or written on the chalkboard for students to enter into memory.

ACTIVITY

1. The turtle can draw circles.

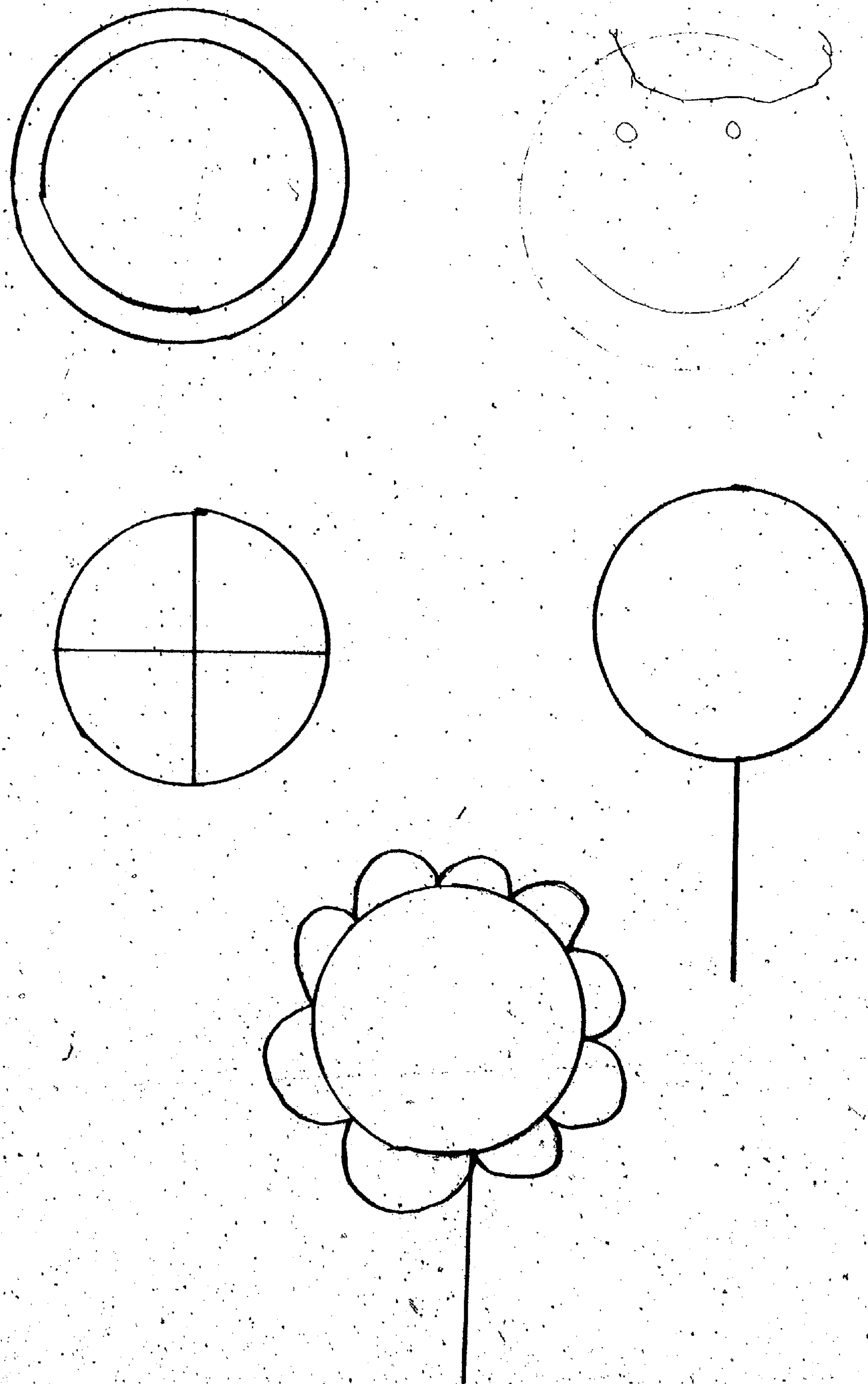
Students are encouraged to 'play turtle' to try and figure out how the turtle would move to draw a circle. They could walk in a circle and think of what they are doing in terms of turtle movements. They will discover that to make a circle they go forward a little and turn a little until they go all the way around.

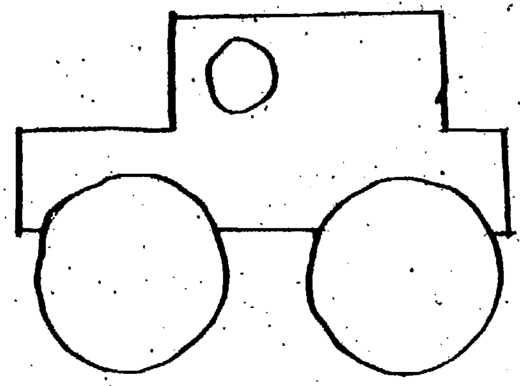
2. Students experiment with drawing circles in DOODLE mode. To give them a guide initially they could load the program CIRCLES into memory and run it.

```
TO CIRCLES
 REPEAT 36 (FD 10 RT 10)
END
```

A large circle will appear on the screen. Then students get into DOODLE mode (@), name their own circle, and by using the one key commands, make the turtle follow the outline to draw their own circle. They can examine their own circle in RUN. This activity can be repeated until the student can draw a fairly accurate circle. The student can then progress to drawing a circle without the outline. A set of workcards would be useful at this stage to give the students some guidelines, but imagination and creativity should be encouraged too.

Some suggestions for workcards :





3. Circles in RUN mode.

Students can experiment with Logo commands to make a circle. They will find it useful to use the REPEAT command, as drawing the circle consists of going forward and turning a little many times until a circle is made. Students will need plenty of time to experiment at this point. Some guidance could be given with the following program 'SHAPES' where the students put in their own values for the number of sides (:N), and the length of each side (:L).

```
TO SHAPES :N :L
 REPEAT :N (FD :L RT 360/:N)
END
```

Students could run SHAPES 10 5 or
SHAPES 5 15 etc.

They can experiment with this program until they have found the best combination of values for a circle.

The students should gradually come to an awareness that there is a relationship between the number of sides and the size of the angles in a circle. An informal way to reinforce this concept is to give them the opportunity to experiment with different variable combinations in the program DRAW.

```
TO DRAW :N :A
```

```
 REPEAT :N (FD 10 RT :A)
END
```

N represents the number of sides, and A is the size of the angle. When the students have tried many different values the teacher could introduce some 'MAGIC COMBINATIONS' :e.g.

:N	:A
36	10
30	12
20	18

Students will discover that by using these combinations they can draw perfect circles. Observant students will notice that in each case the product of the two variables equals 360. Such students can be encouraged to find more 'MAGIC COMBINATIONS', and to use them in the program.

When the students have grasped the method for drawing a circle they can now draw many designs using circles, and combining circles with other shapes. Even simple additions to a circle program can have fabulous results. For example:

```
TO ROUND
 REPEAT 36 (FD 8 RT 10)
END

TO DESIGN
 REPEAT 20 (ROUND RT 18)
END
```

The use of subprocedures should be encouraged. There is almost no limit to the variety of designs the students can produce when they combine all they have learned about Logo with their own imagination and sense of adventure. Teacher guidance should take the form of ensuring that each student is engaged in worthwhile learning, and is being challenged at a level suitable to his/her ability.

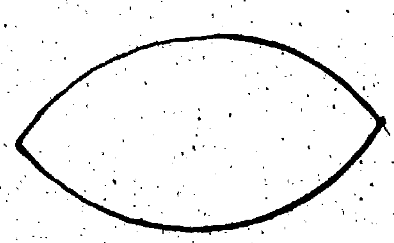
4. Students can expand their experience of constant curvature in a circle by drawing arcs and curved lines of different sizes. This could begin by experimenting with different commands, but students could quickly move to writing procedures using REPEAT and specifying angle size. Many may have grasped the idea of variables in previous programs (more on this in next section), and should be encouraged to use them in their procedures. For example :

```
TO CURVE :T  :A
 REPEAT :T (FD 5 RT :A)
END
```

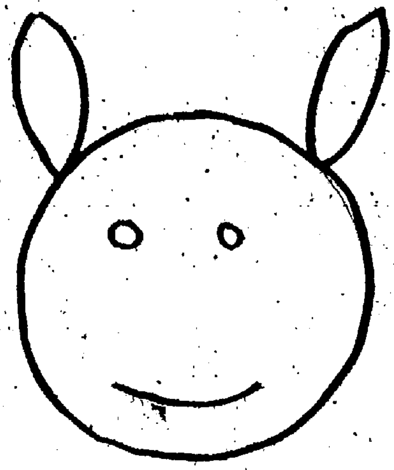
Some suggestions for curves :

a.

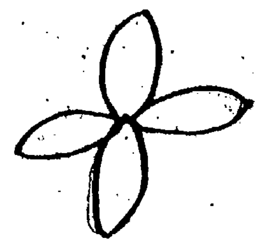
b.



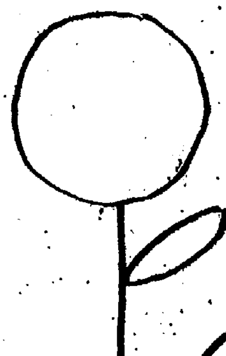
c.



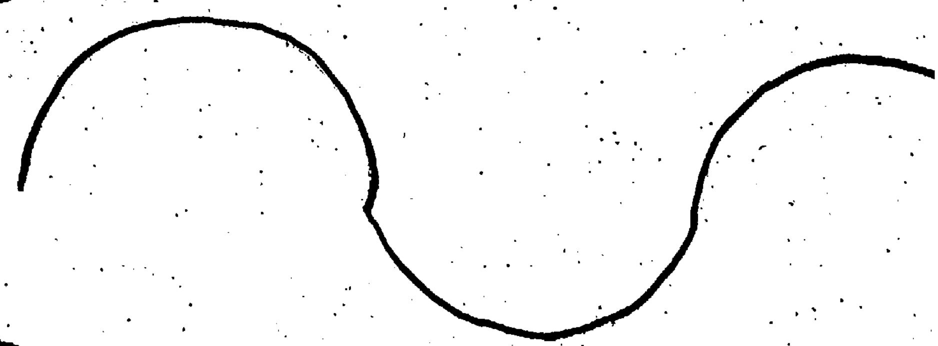
d.



e.

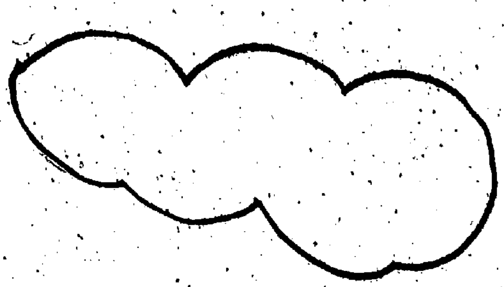


f.

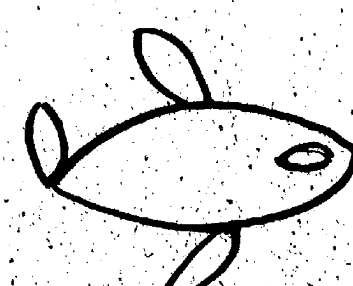


g.

h.



i.



5. VARIABLES.

Variables have been introduced in an informal way to the students, and although they may have used them successfully, some formal instruction may be required to avoid misunderstanding or confusion. Students will have noticed that variables offer great flexibility to their procedures, and that they represent numerical values that the students can change at will. Variables can be used anywhere numbers can be used. The variable is named in the title of the program and consists of a colon (:) followed by any number of letters and /or numbers. For example :

```
TO BOX :SIDE                                  e.g.  BOX  20
 REPEAT 4 (FD :SIDE  RT 90)
END
```

:SIDE is the variable and it allows the student to draw BOX in many different sizes. Students should be given plenty of opportunity to experiment with different variable values. Changing variable values can make a great difference to the results of the procedure. Take SHAPES for example :

```
TO SHAPES :N  :L
 REPEAT :N (FD :L  RT 360/:N)
END
```

Changing the variables to 4 50
7 50
9 50 can change the resulting shape significantly.

Try MORE, changing the variables each time you run it.

```
TO MORE :N  :L  :T
REPEAT :T (SHAPES :N  :L  RT 360/:T)
END
```

Students can experiment with different values in these programs, as well as writing procedures of their own using variables.

6. Making a Masterpiece.

This exercise requires the student to use several procedures, written in both DOODLE and RUN modes, which combine all they have learned in Logo, in order to create their own 'masterpiece'. This would be a complex picture incorporating many shapes and designs. It could be drawn as a visual accompaniment to a story or poem the student had written. Or the student could use his/her imagination to create a masterpiece and then write a story describing the scene. The 'masterpiece could be given a title , and a few sentences could be displayed on screen describing the picture.

```
TO MASTERPIECE
 SY 180 PRINT "MY NEW BICYCLE"
 SY 150 PRINT "I LOVE TO CYCLE IN THE WOODS"
 BICYCLE
 TREES
 HILLS
 SKY
 END
```

MY NEW BICYCLE

I LOVE TO CYCLE IN THE WOODS.

The final procedure, MASTERPIECE would combine a set of subprocedures which the student would have written and run previously, and when combined in the final procedure would make up a picture or scene. This should be fun and should provide a challenge to the students' imagination and programming ability, and also enhance their creative writing. The teacher could use this as an opportunity to incorporate different areas of the curriculum.

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