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ABSTRACT

The proposal put forward in this presentation centers on the use of the microcomputer for the generation of educational research, both as a powerful tool for information collection and as a means for analyzing the generated data. The microcomputer-based laboratory (MBL) principles described in this paper may be used in rural classroom settings as well as in a broader range of research, e.g., city- or state-wide studies. This presentation examines the MBL programming component and its application to a specific research question in special education: the identification of a processing disorder subtype of the learning disabled (LD) student population. The suggestions contained herein are intended for potential researchers who are familiar with microcomputers. Among the advantages of subtype studies are that: (1) they are sensitive to the possibility that typical learners demonstrate cognitive processing strategies similar to those identified in non-typical learners; (2) they are less prone to errors arising from conclusions based on coincidental occurrences; and (3) they are less prone to statistical averaging difficulties encountered when comparing LD students with non-LD students. The increased availability of students resulting from moving the studies to the schools is an added advantage. Findings based on more broad-based locally-defined subgroups of LD students have promise for enhancing the understanding of the LD handicap and, as such, may lead to more effective individual educational plans. State offices of public instruction would particularly benefit from such research in justifying current LD programs to budget conscious legislatures. An Applesoft BASIC program designed to evaluate the dependent variables of performance and reaction time is included as an illustrative analysis of an MBL program. Eight references are listed. (DJR)

Application of Microcomputer-Based Laboratory Programming to On-Site Educational Research: A Proposal.

A paper presented at the Rocky Mountain Educational Research Association conference, Las Cruces, NM, on 23 October, 1985, by David Majsterek, doctoral candidate, Department of Special Education, New Mexico State University.

Application of Microcomputer-Based Laboratory Programming to On-Site Educational Research: A Proposal.

As microcomputers become increasingly implemented in schools across the country two opposing views have been expressed by educators regarding their academic usefulness (Snelbecker, 1981). Some consider the microcomputers to be a technological marvel that will assist in instruction and better prepare children for a computerized society. Others categorize the classroom computer as a passing educational fad comparable to the once in-vogue speed reader. Previewing some available educational software supports this latter contention and makes it difficult to envision more than a brief life for computer aided instruction (CAI). Unfortunately, the necessary coordination between programmers, psychologists, and educators in designing effective and motivating CAI software has not been evident in the end-product (Hofmeister, 1982). Word processing and management programs, on the other hand, have become more sophisticated, availing educators of worksaving tools for recording and computing grades, writing lessons, and designing instructional materials.

Two factors have combined to increase participation in understanding the computer and software programs. First, the omnipresence of microcomputers in school districts (urban and rural alike) makes them at least passively familiar to educators. Second, college credit courses have become locally available to educators interested in becoming computer literate and/or involved in BASIC programming. The familiarity gained through locally available courses enhances the teachers ability to decipher lengthy and sometimes inadequate software documentation. Classroom teachers, actively involved at the programming level, are at an advantage in understanding the processes used to create and run some of the available software in their schools. A practical consequence is that programming knowledge assists the trained teacher in adjusting and adapting existing computer managed programs which require variable input for grading, test and worksheet construction, and word processing.

The proposal forwarded in this presentation centers on the implementation of the microcomputer's strength, its management capacity, for the generation of educational research. The suggestions contained herein are made for potential researchers (teachers, school psychologists, college personnel) who have achieved a fairly comfortable acquaintance with the microcomputer. Those individuals interested in educational research have able to them a powerful tool for the collection of information as well as a means for analyzing the generated data. While the present emphasis is directed toward a broader range of research (city- or state-wide), applications of microcomputer-based laboratoriy (MBL) principles described in this presentation may be directly implemented in the most rural classroom setting. For those inclined to conduct more field proximate studies this presentation examines the MBL programming component and its application to a specific research question in special education which is of interest to the writer; the identification of a processing disorder subtype of the learning disability (LD) student population. In addition, an Applesoft BASIC program designed to evaluate the dependent variables of performance and reaction time is included for an illustrative analysis of an MBL program.

Microcomputer-based Laboratories

Lam (1984-85) has described microcomputer-based laboratories as

> "any laboratory where a microcomputer gathers and displays data directly from the environment. MBL is not simulation, nor a microworld, but a flexible and unified tool for measurement and analysis. The complexity and sophistication of such a tool varies widely: an unadorned microcomputer whose keyboard, screen, and speaker are used to study response times, memory, and perception; one with inexpensive light, temperature, and sound sensors connected as 'game paddles'; and systems used by professional scientists for studying bioluminescence, strengths of materials, functioning of neurons, and many other phenomena. One of the most striking characteristics of MBL is how much science can be done with very simple and inexpensive systems." (pp. 1, 4)

Whereas Lam emphasized the application of the microcomputer to the science curriculum, MBL applications are similarly applicable to educational research.

In the past, laboratory studies of human behavior have typically used complex and expensive devices to measure reaction time, memory, perception, discrimination etc. Current studies in these areas of human performance are still dependent on accurate measurement tools. The need for precision and the consequent need for instrumentation has usually relegated much of this inquiry to areas housing scientific facilities, usually in larger cities or universities. However, with the microcomputer available on just about every academic site, or easily transportable, the researcher who is interested in studying those areas of human performance cited above has available an expanded range of study locations. Couple this instrumentation with a simple mobile laboratory like a modified recreational camper used in some research (e.g. Cosden, Pearl, & Bryan, 1985) and the potential for education studies can be geographically expanded to include the most rural locations routinely.

Application of MBL to Learning Disability Research

The heterogeneity of the LD population has made this group of students difficult to assess and place into consistently effective educational programs. As a result, LD, as a unitary condition which results in academic failure, has become less of a focus in the field. Fisk and Rourke have noted that "it has been demonstrated repeatedly that it is possible to identify reasonable homogeneous subtypes within this heterogeneous population of learning disabled children" (1983, pp. 530-531). Since the federal definition of learning disabilities characterizes the LD individual as having "a disorder in one or more of the basic psychological processes" (Education for All

Handicapped Children Act of 1975, P.L. 94-142, Part B, Sec. 602) research attempting to evaluate what processing deficiencies characterize these students appears to be warranted. The identification of homogeneous LD subtypes promises some advantages which a single factor orientation does not. To begin, this method is sensitive to the possiblity that typical learners demonstrate cognitive processing strategies similar to those identified in non-typical learners (Bayliss & Livesee, 1985). In this regard, studies which attempt to discriminate LD subtypes are less prone to errors arising from conclusions based on coincidental occurrences since "the coincidental occurrence of a reading problem and a processing deficit is not evidence that one causes the other, or that they are related in any important way" (Torgesen, 1982, p. 112). Another advantage of subtype studies is that they are less prone to statistical averaging difficulties encountered in single factor comparisons, that is, studies which compare LD students with non-LD students. Further, some dimensions of psychological processing exhibited by LD students lend themselvesparticularly well to an MBL research approach. Mobilizing this type of study enhances its meaningfulness in that information gathered is more broadly interpretable in light of local assessment decision making practices for states that are attempting to address the high incidence levels of LD students.

To summarize, microcomputers have become broadly available to nearly every schools district and, for those who want to become involved with MBL research, the research tools are on-line locally. In addition, combining MBL programs with mobile labs avails the educational researcher of a means for studying student populations in closer proximity to an academic setting. An increased availability of students resulting from moving the studies to the schools was suggested as an added advantage. Psychological processing deficits of LD students were presented as an area well suited for such examination particularly in relation to the multiple interpretations of these disorders held by professionals in the field and reflected in the assessment methods suggested by local and state education agencies. Findings based on more broad-based, locally-defined subgroups of LD students have promise for enhancing our understanding of the LD handicap and, as such, may lead to more effective individual educational plans. Finally, state offices of public instruction would particularly benefit from such research in justifying current LD programs to budget conscious legislatures.

The following software program was created to measure a hypothesized processing deficit which may characterize a facet of the diagnosed LD student's difficulty with reading. While it is beyond the scope of this presentation to consider the underlying research support for this focus, the target independent variable is termed Varying Response Expectancies (VRE). This variable is best described as a student's awareness of task components which vary without prior indication and the student's efficient use of strategies to adapt to this varying expectancy. An example would be a consistent failure to change strategies on a math paper which is basically addition but contains several subtraction problems. The criterion variables are performance (number of presentations to criterion) and average response time to presentations. This study is currently being proposed to different rural school districts as a component of the writer's doctoral dissertation.

The Program

The MBL program which follows is the heart of four different task programs for the study briefly described above. These include a Baseline, and three different Task programs, each called from a menu. (A complete copy of this MBL-based program is available to interested individuals by sending two disks to the presenter.) Since the data sets (lines 20399 - 20799) comprise the independent variable stimuli, alteration of these in the other three programs constitutes the main distinction between different task routines. The program is written for an Apple IIe microcomputer using one disk drive. However, an adaptation has been developed for use with one disk drive and a simulated disk drive in slot 3, the 64K extended memory card. Graphics accomodations reflect the use of The Graphics Magician by Penguin Software.

Statements are defined and dimensioned from lines 1000 to 1120 and adaptations for graphics routines are included in lines 1140 and 1240 to 1300. Data statements (stimulus picture pairs) are gathered using lines 1180 to 1230 and presented (lines 1480 - 1540) after a random delay (lines 1340 - 1460). A timing counter in the program begins at 1560 and runs through 1620. Responses from the student are in the form of button selection on a graphics tablet but may include paddle buttons or open and solid apple keys on the IIe keyboard (lines 1580 - 1600).

Button selections are compiled either through line 1660 (paddle 0) or line 1680 (paddle 1) and response time is computed in line 1740. Lines 1780 to 1800 total the correct responses to stimulus presentations and 1840 to 1960 ask the student to indicate when they are ready for the "NEXT" stimulus pair. Lines 1980 to 2220 do the following: total the number of seconds per response; determine if two-of-ten presentations have been missed (criterion is nine of ten correct); and return to the beginning of the program loop (line 1220) for the next presentation. Lines 2280 to 2500 average the number of seconds to respond, total the number of presentations and number of trials, and present these results on the monitor for the researcher to record. Lines 2520 to 2600 comprise a routine for returning to the main menu.

<u>MBL program for presenting visual stimuli until criterion -9/10 presentations correct- is reached and computing performance and response time</u>.

```
1000 J = 1: TR = 1: T = 41: BC% = 0: BT = 0: BP = 0
1020 P0 = - 16287:P1 = - 16286: REM *** DEFINE PADDLE POKES
1040 DT = .0131: REM *** * TIME PER COUNT (A CALIBRATED CONSTANT)
1060 KB = 49152: REM *** * KEYBOARD ADDRESS
1080 L = 128: REM *** KEYBOARD ASCII CHARACTERS
1100 LL = 127: REM *** PADDLE PEEK VALUE EXCEEDED WHEN PADDLE
     BUTTON IS DEPRESSED
1120  DIM E$(T): DIM F(T): DIM G(T): DIM H(T)
1140  PRINT CHR$ (4); "MAXFILES1": REM *** FOR GRAPHICS PROGRAM
1160  HOME
1180  RESTORE: REM *** ALL READ AND DATA STATEMENTS WILL BEGIN
      ANEW
1200  FOR M = 1 TO T: READ E$(M): READ F(M): NEXT M: REM *** NOW
      READING ALL DATA
1220  FOR M = 1 TO T: REM *** THIS IS WHERE THE TRIAL LOOP BEGINS
1230  IF M = 1 THEN  GOSUB 30000: REM *** SUBROUTINE TO GET BEEP ON
      FIRST PRESENTATION
1235  HOME: PRINT
1240  HIMEM: 32768: REM *** FOR GRAPHICS PROGRAM
1260  PRINT CHR$ (4); "BLOAD PICDRAWH": REM *** FOR GRAPHICS
```

```
1280  PRINT CHR$ (4); "BLOAD"; E$(M); ".SPC,A32768"
1300  HOME: PRINT
1320 C% = 0: REM *** RESET C%, THE LOOP COUNTER
1340  POKE 49168,0: REM *** EARLY KEYBOARD PRESSES ARE IGNORED
1360  FOR I = 0 TO 300: NEXT I: REM *** A FIXED DELAY
1380  FOR I = 0 TO 300 * (.2 +  RND (1)): REM *** A RANDOM DELAY
1400  IF PEEK (KB) > L THEN 1340  REM ***EARLY PRESSES WILL BE*
1420  IF PEEK (P0) > LL THEN 1340 REM ***IGNORED FROM KEYBOARD*
1440  IF PEEK (P1) > LL THEN 1340REM  ***OR FROM PADDLES      *
1460  NEXT I
1480  HGR
1500  POKE 0,0: POKE 1,128: REM *** PREPARES SCREEN FOR PICTURE CALL
1520  CALL 36096
1540  INVERSE: VTAB 22: HTAB 18: PRINT "SAME?":
      NORMAL: PRINT CHR$ (7): PRINT: REM *** BEEP CUE
1560 C% = C% + 1: REM *** LOOP COUNTER
1580  IF PEEK (P0) > LL THEN 1660:
      REM *** IF LEFT BUTTON IS PUSHED G(M) WILL EQUAL ONE
1600  IF PEEK (P1) > LL THEN 1680:
      REM *** IF RIGHT BUTTON IS PUSHED G(M) WILL EQAL ZERO
1620  GOTO 1560
1640  REM *** COUNT ROUTINE FOLLOWING STIMULUS PRESENTATION
1660  TEXT: HOME: G(M) = 0: GOTO 1740:
      REM *** SUBJECT RESPONDS WITH PADDLE 0
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```
1680  TEXT: HOME: G(M) = 1: GOTO 1740:
      REM *** SUBJECT RESPONDS WITH PADDLE 1
1700  VTAB 22: REM *** BYPASSED FOR NOW BUT GOOD PLACE
      FOR IMMEDIATE TIME FEEDBACK
1720  TEXT: HOME
1740 Q = (.01 *  INT (100 * DT * C% + .5)): PRINT:
      REM *** SUBJECTS TIME IN SECONDS
1760  FOR K = 1 TO 400: NEXT K
1780  IF F(M) <  > G(M) THEN H(M) = 0:
      REM *** THIS IS AN ERROR AND WILL BE USED IN E-A ROUTINE
1800  IF F(M) = G(M) THEN H(M) = 1:
      REM *** THIS IS A CORRECT RESPONSE
1820  HOME: VTAB 10: HTAB 18: INVERSE: PRINT "NEXT": NORMAL:
      PRINT CHR$ (7)
1840 D% = 0: REM *** RESET TIME BETWEEN COUNTER
1860 D% = D% + 1: REM *** TIME BETWEEN STIMULUS COUNTER
1880  IF PEEK (P0) > LL THEN 1940
1900  IF PEEK (P1) > LL THEN 1940
1920  GOTO 1860
1960  HOME
1980 BT = BT + Q: PRINT: REM *** TOTAL TIME IN SECONDS
2000 BC% = BC% + H(M): PRINT: REM *** TOTAL NUMBER CORRECT
2040 Y% = 0: REM *** CRITERION COUNTER
2060 Z% = 0: REM *** TRANSPOSED COUNTER
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```
2080  IF J = M THEN GOTO 2220: REM *** FOR THOSE SITUATIONS
      WHEN ONLY ONE TRIAL IS COMPUTED
2100  FOR X = J TO M
2120 Z% = Z% + H(X): REM *** THIS WILL TOTAL THE CORRECT
     RESPONSES H(M)
2140 Y% = Y% + 1: REM *** THIS IS THE STANDARD COUNTER
     AGAINST WHICH TWO WRONG IS MEASURED
2160  IF Y% > (Z% + 1) THEN  GOTO 2620: REM *** WHEN Y IS 2 BIGGER
      IT MEANS TWO MISTAKES HAVE OCCURRED IN A TEN SERIES AND A NEW
      TEN SERIES WILL BEGIN
2180  IF Z% = 9 THEN GOTO 2260: REM *** HOORAY
      CRITERION HAS BEEN MET
2200  NEXT X
2220  NEXT M
2260  HOME
2280 TIB = ( INT (100 * BT / (M))) / 100:
      REM *** AVERAGE TIME TO RESPOND
2300 COB = ( INT (100 * BC% / (M))) / 100:
      REM *** AVERAGE NUMBER CORRECT
2360  INVERSE: PRINT "BASELINE - FIXED POS SHAPES": NORMAL
2380  PRINT "TOTAL PAIRS PRESENTED  =>"; M
2400  PRINT "AVG. TIME PER RESPONSE =>"; TIB
2460  PRINT "TRIALS TO 90% ACCURACY =>"; TR
2470  PRINT "E-A => ";:REM *** ERROR ANALYSIS DATA
```

```
2472  FOR S = 1 TO M
2473  IF H(S) = 0 THEN PRINT "#";S;" ";
2474  NEXT S
2480  PRINT: INVERSE: PRINT: PRINT "**********************
      ********************"
2500  PRINT "REMEMBER TO RECORD ALL DATA BEFORE RETURNING TO
      MAIN MENU"
2520  PRINT: HTAB 5: INPUT "RETURN TO MAIN MENU? (Y OR N)"; O$
2540  IF O$ = CHR$ (89) THEN GOTO 2580
2560  HOME: GOTO 2340
2580  PRINT "PRESS ANY KEY TO RETURN TO MAIN MENU": GET Q$
2590  HOME: PRINT
2600  PRINT CHR$ (4); "RUN AR1": REM *** RERUNS THE HELLO PROGRAM
2620 TR = TR + 1: REM *** THIS IS THE COUNTER WHICH TELLS HOW MANY
     TRIALS HAVE BEEN UNDERGONE TO REACH THE CRITERION OF 9/10
     CORRECT
2640 J = M + 1: REM *** WHEN A FAILURE TRIAL IS REACHED THE NEW J WILL
     START A NEW TRIAL FROM THE POINT WHERE THE LAST ONE LEFT OFF
2660  GOTO 2220: REM *** WILL RETURN TO 6650
20000  REM *** ***********************
20100  REM ***      * BASELINE - FIXED
20200  REM ***    * POS SHAPES
20300  REM *** ***********************
20399  DATA XX14,1,XX6,0,XX17,0,DX3,1,XX7,0,XX19,1,
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      XX20,1,XX13,0,XX18,1,XX
20499 DATA XX5,1,XX15,1,XX2,0,XX1,0,DX1,1,XX11,1,XX21,0,
      DX7,1,XX12,1,XX9,0
20599 DATA XX8,0,XX16,0,XX8,0,XX17,0,XX11,1,DX7,1,
      XX21,0,XX14,1,XX18,1,XX2,0
20699 DATA XX6,0,XX13,0,XX1,0,XX15,1,XX9,0,DX1,1,
      XX19,1,XX16,0,XX7,0,DX3,1
20799 DATA XX5,1
30000 HOME: VTAB 10: HTAB 18: INVERSE: PRINT "NEXT": NORMAL
30005 PRINT CHR$(7)
30010 IF PEEK (P0) > LL THEN RETURN
30020 IF PEEK (P1) > LL THEN RETURN
30030 GOTO 30010
```

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