Microcomputers in Observational and Field Research

Using the PET microcomputer for collecting and analyzing observational data in the classroom

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This report concerns the use of the PET 2001-8 microcomputer (Commodore) for taking observational data on human interactions in a classroom setting. The program enables the observer to record several different types of behavior as they occur in time and provides for calculations of frequency, duration, and latency data for the behaviors observed, using the real-time clock built into the PET. During field testing in a classroom, an observer can accurately record sequential teacher-student interactions. Because of the integration of processor, TV monitor, keyboard, and cassette deck, the PET is very portable, which increases its flexibility for observing behaviors in naturalistic settings.

Recently, a demand was expressed by several investigators at Utah State University for a low-cost device to record observational data from human subjects in the classroom. Durrett (1978, Note 1) has described the advantages of the PET 2001-8 (Commodore Business Machines, Inc.) microcomputer for psychological research, so a PET was purchased. This paper describes the system and our experiences with it in observational research.

The PET is a low-cost (\$795) self-contained unit that consists of a keyboard, TV monitor, cassette tape deck, and a 6502 8-bit (1-byte) microcomputer in a metal housing weighing a total of 44 lb (see Figure 1). Also included are 8K of user-available random-access memory (RAM) and an internal real-time clock. The 9-in. TV monitor permits the display of 1,000 characters (24 × 40) and is usually less visually fatiguing than many of the converted TV sets that are often used in conjunction with microcomputers. The cassette recorder, which uses standard audio cassettes, is used to store programs entered via the keyboard and has been found to be quite reliable for storing and reloading. The nonstandard keyboard, consisting of 73 keys, is a bit small for touch typing. A standard-size keyboard will be available soon. In addition to alphabetic and numeric keys, 64 graphic characters can be put directly on the video screen by shifting. Keys are also provided that make it easy to edit material directly on the video screen. Unlike other similarly priced models (e.g., the Radio Shack system), the keyboard, TV monitor, and cassette are integral to the unit for easy portability.

The PET's language is a powerful and fast version of extended BASIC, which is easy to learn and use.

The BASIC interpreter that resides in 8K read-only memory (ROM) is ready to use as soon as the machine is turned on. A 4K operating system is also supplied in ROM. PET's BASIC can handle strings, integers, multiple-dimension arrays, and 10 significant digits. The operating system permits the use of other languages, allows true random-number generation, and the use of 6502 machine language.

Of vital importance to the psychologist who wishes to record time intervals or durations is the internal real-time clock. Through BASIC, this clock can be read or reset, and will time events with millisecond accuracy.

Figure 1. Observer using PET microcomputer to record and analyze behavior of student and teacher in classroom.

For interfacing various devices to the PET, an IEE 488 bus is provided. An 8-bit parallel user port also projects from the rear of the machine. If the user wishes to expand the amount of RAM memory beyond the 8K provided, a separate port is available for adding up to 24K (a total of 32K) of RAM. Commodore has also announced a printer (\$595) that will be marketed in September 1978. This will be an impact printer (120 characters/sec) that uses 8.5-in. wide paper, such as that used on many printers currently. A second cassette deck (\$99) that simply plugs into the PET is also available.

FIELD TESTING

In order to determine the practicality of using the PET in the classroom, observations were conducted during nine sessions in which a single observer recorded data on sequential student-teacher interactions in a classroom of handicapped students at the Utah State University's Exceptional Child Center. Seven different behavioral categories were chosen (start task, end of task, teacher begins prompt, teacher ends prompt, off task, teacher praises, and teacher reprimands), and the behaviors of a single student and teacher were recorded in these categories during an approximately 20-min observation period. A separate key on the keyboard was dedicated to each of the seven categories and labeled with the first two letters of the category to help the observer select the appropriate key. Prior to the session, the observer loaded the cassette tape with the observation program (see Table 1) into the PET. After the observer had started the program, the following message was printed on the TV screen.

Computer Prints: INPUT THE BEHAVIOR CODES ACCEPTED
INPUT A 99 WHEN DONE
BEHAVIOR CODE
Observer Types: ? L
Computer Prints: INPUT DESCRIPTIVE WORD(S)
Observer Types: ? TEACHER PRAISES
Computer Prints: BEHAVIOR CODE
Observer Types: ? M
Computer Prints: INPUT DESCRIPTIVE WORD(S)
Observer Types: ? STUDENT ON TASK

This initialization dialog continues until the observer has assigned an arbitrary letter (behavior code) to each category of behavior (descriptive word). The field testing utilized seven categories, although more categories can be added easily. During the last two observation sessions, an eighth category (teacher ignore student response) was in fact added to more accurately reflect the type of interaction taking place.

The observer then gives the computer a command to start the real-time clock, and he begins observations. When a behavior occurs and falls into one of the preassigned categories, the observer presses the appropriate key. As he does so, the key's letter appears

on the screen along with the descriptive word. The time of day the key was pressed is stored but does not appear. The sample program also contains a routine for correcting data entry should the wrong key stroke occur. Thus,

Observer Types:	Computer Prints:
L	TEACHER PRAISES
M	STUDENT ON TASK
L	TEACHER PRAISES

and so on.

After the session is over, the observer types a "9" to signal the session's termination and the computer prints the following information on the screen:

000006	TEACHER PRAISES
000010	STUDENT ON TASK
000011	TEACHER PRAISES
000015	STUDENT ON TASK

and so on.

The numbers on the left are the number of seconds since the session began that the behavioral event, shown to the right, occurred. The computer then prints out the number of occurrences of each event recorded. Then the portion of the program dealing with data analysis is initiated (not shown in Table 1). Suppose that the data of interest are latencies between the events "student on task" and "teacher praises." Specifically, our interest is in the frequency, the latencies between occurrences of pairs of events, and the mean and standard deviation of these latencies.

Computer Prints: TYPE FIRST LETTER OF BEHAVIOR
CODE TO BE ANALYZED

Observer Types: ? L

Computer Prints: TYPE SECOND LETTER OF BEHAVIOR
CODE TO BE ANALYZED. TYPE 99 WHEN
DONE.

Observer Types: ? M

The computer sorts out all instances of L followed by M. It then subtracts the times of the second event (M) from the immediately preceding event (L), and prints each occurrence of L followed by M plus the latency between each occurrence of these event pairs. It then calculates and prints the mean and standard deviation of these latencies. Of course, it is possible to have the PET perform more complicated analyses such as a t test or a simple one-way analysis of variance if these statistics are called for, but these were not of interest in the present case. These respective programs may be written in BASIC or purchased.

Perhaps it is important at this juncture to point out some limitations imposed by the PET's memory size. In the example given above, the programs used to acquire the data and to analyze it are stored in memory at the same time. This restricts the amount of space

Table 1
Program in PET BASIC for Observational Settings

```

10      REM PROGRAM ICU
15      REM OBSERVATION PROGRAM
25      DIM A$ (9), D$ (500), BE$ (500), MESS$(9)
50      N=0: L=0
100     PRINT "PROGRAM ICU RUNNING"
110     PRINT
120     PRINT
200     PRINT "INPUT THE BEHAVIOR CODES ACCEPTED"
300     PRINT "INPUT A 99 WHEN DONE"
400     PRINT "BEHAVIOR CODE": INPUT A$(N)
402     IF N=9 THEN GOTO 530
403     IF A$(N)="99" GOTO 530
405     PRINT "INPUT DESCRIPTIVE WORD"
422     INPUT MESS$(N)
425     N=N+1
430     GO TO 400
530     PRINT "TYPE 100 WHEN READY TO START"
535     PRINT "TYPE A 9 FOR THE BEHAVIOR CODE WHEN READY TO STOP"
540     INPUT X
550     IF X<>100 THEN GOTO 530
572     GET C2$: IF LEN (C2$)=0 GOTO 572
573     GOSUB 1000
577     IF C2$="9" GOTO 740
660     FOR T=0 TO N
670     IF C2$=A$(T) GOTO 710
680     NEXT T
685     IF C2$="E" THEN GOTO 1300
690     PRINT "NO SUCH BEHAVIOR CODE"
700     GOTO 572
710     D$(NBEHAV)=TIS$
712     BE$(NBEHAV)=C2$
714     PRINT NBEHAV; MESS$(T)
720     GOTO 572
740     MAXB=NBEHAV
750     NBEHAV=0
755     B$=TIS$
758     FOR Q=0 TO N
760     IF BE$(NBEHAV)=A$(Q) GOTO 765
762     NEXT Q
765     PRINT D$ (NBEHAV), MESS$ (Q)
767     GOSUB 4300
770     IF NBEHAV=MAXB GOTO 1500
780     NBEHAV=NBEHAV+1
790     GOTO 758
1000    GET Z
1005    IF Z=0 THEN RETURN
1010    GOTO 1000
1300    PRINT "ERROR ROUTINE"
1310    PRINT "INPUT NUMBER OF BEHAVIOR TO CHANGE"
1320    INPUT EN
1330    PRINT "INPUT CORRECT BEHAVIOR CODE"
1340    GET C$: IF C$="" GOTO 1340
1345    PRINT C$
1350    BE$(EN)=C$
1360    GOTO 700
1500    FOR T=0 TO N
1510    COUNT=0
1520    FOR N=0 TO MAX B
1530    IF A$(T)=BE$(N) THEN COUNT=COUNT+1
1540    NEXT N
1550    PRINT "NUMBER OF"; MESS$(T); " " COUNT
1555    GOSUB 4300
1560    STOP
4300    LCNT=LCNT+1
4310    IF LCNT<20 THEN RETURN
4320    LCNT=0
4330    PRINT
4340    PRINT "PAUSE"
4350    GET DUMMY$: IF DUMMY$="" GOTO 4350
4360    RETURN

```

reserved for storing incoming data in memory. Specifically, if, in the present case, the observer types in two to three words for each instance of a descriptive word during the initialization procedure, only about 146 distinct events can be recorded before running out of memory space. Thus, after observing for 10-20 min in the present situation, the observer will have to stop in order to avoid losing data. If briefer descriptive words are used (e.g., TP instead of "teacher praises"), then about 170 events can be recorded. This number can also be increased by other methods, such as adding more memory to the PET, or by writing incoming data out to the cassette tape as these data are coming in. After the session is over, these data, along with the analysis program, can be read back into the PET and analyzed. The only problem with this method is that during the "writing-on-cassette" phase, the PET cannot record incoming data. Thus, during this 6- to 10-sec period required to write the data out to cassette, it is possible to lose incoming data. This may or may not be a problem, depending upon the tempo of events being observed. If it is a problem, then adding memory is the answer; 16K of additional RAM, not yet available from Commodore, can be purchased for about \$500 from Convenience Living Systems of Sunnyvale, California.

The above illustration was concerned with latency data, but other types of temporal and frequency data can be recorded as well, and in fact were recorded during the field-testing sessions. For example, if response duration is of interest, the initialization dialogue looks like this:

```
Computer Prints: BEHAVIOR CODE
Observer Types: ? L
Computer Prints: INPUT DESCRIPTIVE WORD(S)
Observer Types: ? TEACHER'S QUESTION INITIATED
Computer Prints: BEHAVIOR CODE
Observer Types: ? M
Computer Prints: INPUT DESCRIPTIVE WORD(S)
Observer Types: ? TEACHER'S QUESTION ENDS
```

Then, during the observational session, "L" is pressed when the teacher begins a question, and "N" is pressed when the teacher ends that question. Subtracting the "N" time from the "L" time yields the duration of the response. If time-sampling data are required, the real-

time clock can cause a message to be printed on the screen, "TAKE DATA NOW," at specified intervals. During these periods, the observer, after following a similar initialization process to that described in the latency example, simply presses the appropriate key each time one of the target behaviors occurs.

In the field testing, the advantages of the PET were threefold. First, it was not necessary to stop watching a child while recording data, as with paper and pencil techniques. Second, the obtrusiveness of the system seemed no worse than with paper and pencil techniques. Third, rather than recording the target behavior alone (as with most other systems), the PET enabled the observer to precisely identify the antecedent and consequent events surrounding the behavior. Since events were expressed in real-time units, more precise measurement of the events controlling the children's behavior was possible. One tremendous advantage, besides low cost, that the PET has over similar systems is that it is totally self-contained. Both data acquisition and analysis can be performed on the same instrument. Due to its self-containment and relatively light weight, the PET is a reasonably portable unit. By placing the PET on a wheeled table, it was possible to follow teacher-student interaction even when the person being observed moved from place to place in the classroom, as frequently occurs in naturalistic settings.

In summary, we are quite satisfied with the PET for measuring human interactions in observational situations.

REFERENCE NOTE

1. Durrett, H. J., Jr. *A dream or reality? A real-time laboratory for under \$1,000*. Paper presented at the National Conference on the Use of On-Line Computers in Psychology, Washington, November 1977.

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