SOME COMPARISONS BETWEEN SEE/WRITE AND SEE/TYPE ARITHMETIC TIMINGS

William D. Wolking
University of Florida

Susan Sakowitz
University of Florida

Elizabeth Nancarrow
Gainesville Academy

Purpose

Microprocessors make it possible to present new educational contingencies and to make the measurement of educational outcomes more accurate and relevant (Lindsley, 1981). This study explored the feasibility of microcomputer-administered arithmetic timings for elementary school children. Doing arithmetic on a microcomputer involves a new learning channel set—see/type.

This study compared traditional (written) with microcomputer (typed) arithmetic timings. The primary objective was to take young students with no typing skills or microcomputer training and see how basic arithmetic timings on the microcomputer compared with traditional see/write timings after 20 days of brief daily practice. Comparisons included tool movements (between think/write or think-type and see/write or see/type digits) and also arithmetic skills (between see/write and see/type addition, subtraction and multiplication facts). Arithmetic performances were also compared with their appropriate tool movements.

Setting

This study was conducted in a private school for normal, but low-achieving, children. The school uses Precision Teaching for much of its basic arithmetic instruction. Classes are small, limited to 9 pupils per teacher. Microcomputers were introduced to the setting shortly before this study took place. Most of the children had become generally familiar with the microcomputers by playing arcade type games on them.

Subjects

Twenty-two children, 16 boys and 6 girls, between the ages of 6 and 12 took part in this study. Most were low-achieving or disruptive regular class students. None were classified as special education students, and none of the students had formal typing or computing instruction.

Dependent Variables

The frequencies of ten pinpoints were recorded. Think/write (1) and think/type (2) digits in sequence. See/write (3) and see/type (4) digits, random order. See/write and see/type addition facts (5 & 6), subtraction facts (7 & 8) and multiplication facts (9 & 10).

Independent Variables

Students were matched on previous arithmetic performance and then randomly assigned to one of two groups. See procedures for details. Group I took only traditional see/write and think/write timings. Group II did two sets of timings each day. They did the traditional timings just as Group I did, and they also took a set of timings on the microcomputer, the think/type and see/type learning channel set timings. Thus, two conditions serve as independent variables—the output learning channel (write or type) and the number of daily timings (five or ten).

Apparatus and Materials

See/type timings were done on four Atari 800 microcomputers. Three computer programs presented random samples of addition, subtraction and multiplication fact problems each day. Each program signed the students on, timed their performance (1 minute), calculated and displayed frequency correct and incorrect in the lower right corner of the screen, and saved the data from each timing on a 5-1/4 inch floppy diskette. See/write math fact timings were done using 8-1/2/ x 11 inch math fact probes oriented horizontally. Addition facts included sums to 18. subtraction probes had differences to 9 and multiplication sheets included facts through 9 x 9. Problems on the paper probes were arranged in random order daily through the use of different sheets and different starting points.

Procedures

Students were matched according to previous arithmetic performance frequencies on see/write timings, without regard for age, sex or type of conduct problem. The highest of each student's last five consecutive timings was recorded for addition, subtraction and multiplication facts. The total of these three frequencies was used as the child's performance score. Students were then paired by matching these performance scores. One of each pair was assigned randomly to either Group I (see/write only) or Group II (both see/write and see/type).

The procedures listed below were used to gather the data, on a daily basis, over a period of four

consecutive weeks.

a) Each Group I student (N=11) took five math timings a day (think/write digits in sequence, see/write digits random and see/write addition, subtraction and multiplication facts). Group I served as a check on see/write timings.

b) Each Group II student (N=11) took ten math timings a day (think/write and think/type digits in sequence, see/write and see/type digits random order, see/write addition, subtraction and multiplication facts, and see/type addition, subtraction and multiplication facts). Group II makes it possible to compare see/write and see/type data on the same students.

c) All see/write and think/write timings were done in the regular classroom.

d) All see/type and think/type timings were done on Atari microcomputers. Students left their classroom to take these timings.

e) There were no practice timings on either write or type probes.

f) See/write probes started on a new line of the probe sheet each day, to approximate the random order of presentation of the computer-administered probes.

g) During the last week all students checked and charted their see/write frequencies. The classroom teachers had not permitted student checking and charting during the first three weeks of the study. See/type timings included a presentation of the frequency correct and incorrect in the lower right corner of the screen within two seconds of the end of the timing.

The data presented are based on the median score for each student, on each probe, for the last week of data. All but one child achieved their best performances during the last week. Celerations are not included because some of the frequencies from the first two weeks were not saved on diskette properly.

Results

Chart 1 presents the data on a summary chart. It includes the ranges of correct frequencies and the group medians for Groups I and II on each of the five skills (2 tool movements and 3 arithmetic fact pinpoints). Group I data (see/write timings only) are charted using single vertical marks. Group II data are charted using double vertical marks.

Random Assignment Results

A brief study of Chart 1 shows the results of the matching and random assignment procedure described above. The two groups are functioning very much alike on the two tool movements and on see/write add facts. However, Group I is functioning above Group II on subtraction and multiplication facts. The medians for Group I for subtraction and multiplication are X1.4 and X1.6 higher than Group II. An explanation for these differences is not apparent.

Tool Movement Comparisons

The students found it quicker to think/type digits in sequence than to think/write digits in sequence. During the four weeks the median think/type performance was X1.8 faster than the median think/write performance. However, it was X1.8 quicker to see/write random digits than to see/type random digits. This difference might be smaller on computer keyboards which have a calculator style keypad for entering digits. Additional data are needed on this question.

Arithmetic Fact Comparisons

The comparisons of interest here are within Group II, the group that did both see/write and see/type math fact timings. The median see/write performance is consistently more rapid. The frequency multipliers (see/write frequency correct divided by see/type frequency correct) are: addition X1.2; subtraction X1.2 and multiplication X1.3.

Comparisons Between Tool Movements and Arithmetic Facts

Again, there are within group comparisons. Chart 1 shows that for Group I, the median see/write tool movement frequency ranged from X1.4 to X2.1 above the median see/write arithmetic fact frequency. For Group II, the median see/write tool movement frequency ranged from X2.3 to X2.5 above the median see/write arithmetic fact frequency.

For Group II, the median see/type tool movement frequency was X1.6 above all three median see/type arithmetic fact frequencies. Group II performed see/type arithmetic facts considerably closer to their see/type tool movement frequencies. This may be because these tool movement frequencies are relatively low. But it is not obvious that it is easier to "approach" a low tool movement frequency than a high one.

Discussion and Conclusions

The elementary school students in this study had no formal training with microcomputers. Most of

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Behavior Research Co.
Box 3351 Kansas City,
Kansas 66103
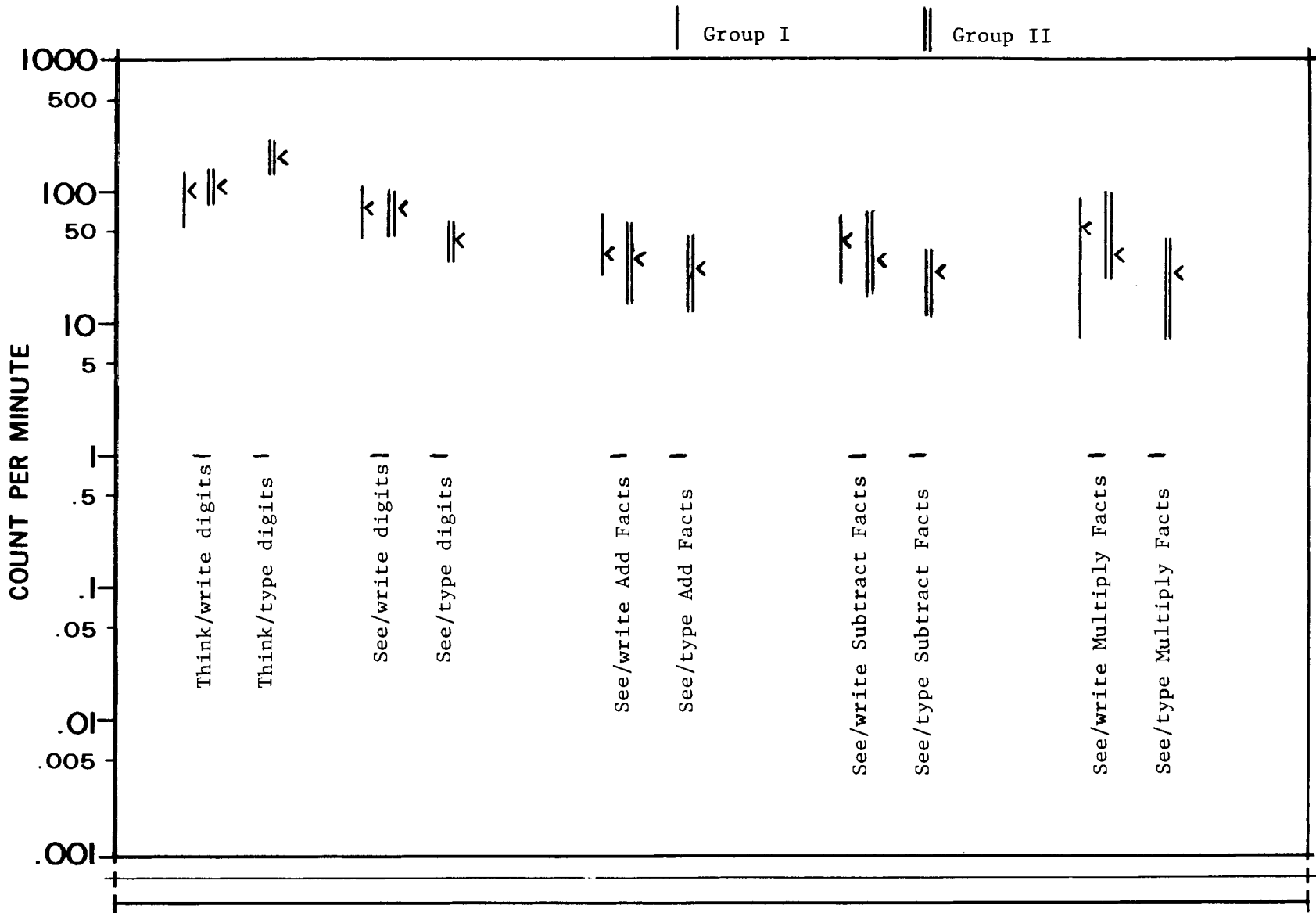

Chart 1. Ranges of Correct Frequencies and Medians for Groups I and II on Five Skills

Wolking   Sakowitz   Nancarrow   22 students   digits

Gainesville Academy   Gainesville, Florida

DAILY CHART TRACER (CT-8)

them did have about 40 days of experience playing games on the Atari 800 microcomputer. Twenty days of daily one minute timings on basic addition, subtraction and multiplication facts produced the results presented above.

At the end of this experience most of the students were not doing as well on microcomputer-administered, see/type, timings as they were on teacher-administered, see/write, timings. However Group II, the only group doing both see/write and see/type timings, showed only a slight advantage in frequency of see/write over see/type. Explicit keyboard training and a longer or more intensive experience with the microcomputer may overcome the advantage of the see/write learning channel set. Accuracy results were not presented because accuracy was uniformly high, fewer than 3 or 4 errors per minute, for both see/write and see/type. If there was an accuracy advantage, it was a small one for see/type timings.

The data on tool movements and math fact timings are not easy to interpret without indulging in speculation. They are included here primarily as a contribution to an evolving data-base in this relatively new area of Precision Teaching.

Much research is needed before we can determine which educational contingencies are best managed by microcomputer. Certainly the microcomputer has imposing credentials. If it can teach skills effectively, teachers may be able to concentrate on more advanced aspects of skill measurement and development. The Atari 800 is clearly capable of presenting math drill and practice lessons at rates which will not impose machine ceilings on fluency for human learners. All of the popular microcomputers are capable of being programmed to calculate frequencies and store them in a file on tape or diskette. The Atari is capable of presenting the child's learning on semi-log charts done in four colors, including learning lines, aim stars, record floors and the usual features of the Standard Celeration Charts.

We also need to start exploring the use of programs that apply data-decision rules to frequencies stored in the student's learning file. It seems likely that in the near future this application of decision rule technology will signal the learner and teacher that a change is needed before additional time is spent on an ineffective procedure. The potential of the floppy diskette for quick and semi-permanent storage of student's learning frequencies may be a substantial contribution to Precision Teaching. Floppy diskettes have great potential for making it possible to share and analyze the huge amount of data generated by precision learners and teachers.

REFERENCE

Lindsley, O. R. Frequency, celeration, correction and reinforcement in micro-processed education. Invited address at the Association for Behavior Analysis, Seventh Annual Conference, Milwaukee, Wisconsin, May 1981.

THE RELATIONSHIP OF FREQUENCY TO SUBSEQUENT SKILL ACQUISITION

Susan S. Evans
Pensacola Junior College

Cecil D. Merger
University of Florida

William H. Evans
University of West Florida

The issue of skill proficiency is perhaps the most important issue in education today. It involves the evaluation of students in elementary school through college, and is of such great concern that laws have been enacted to ensure that students are proficient in certain skills.

Teachers must make decisions daily concerning when to advance a student from one skill to the next. In the past, a time criterion was sometimes used. For example, when working on multiplication facts, a student might spend one week practicing his two-times table, then go on to the three-times table the following week. Individual differences were ignored with this method.

With the advent of Precision Teaching, specification of precise personalized aims for children began to emerge in classrooms. A well-specified aim includes a definition of pupil response, conditions under which that response should occur, and criteria for acceptable performance (Haring & Bateman, 1977). Criteria for acceptable performance and advancement to the next skill, that is, proficiency criteria have often been set in terms of frequency correct and incorrect.

Some disagreement exists about what constitutes proficiency (Haring & Gentry, 1976). A review of the literature suggests that research has not conclusively determined specific optimum proficiency criteria for academic skills. Different guidelines are available to assist teachers in determining when to advance children, but there is little specific research or agreement as to which guideline to use. One