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ABSTRACT

Forty-one research studies completed between 1929 and 1983 investigated the effects of typewriting on the development of children's language arts skills. Information about each of the studies was entered in a Lotus 1-2-3 database containing 43 fields. Effect sizes were calculated for 21 studies. The collected evidence suggests a small positive effect of the use of typewriters on reading, word identification, syntax, and spelling skills. The study reveals a greater potential positive effect on the development of writing skills. Subjective reports favored the typewriter as a motivating tool. Students in the primary grades can be expected to profit most from typewriting; touch typing yielded no more significantly positive results than the hunt-and-peck method. Increased access to computer applications software in the classroom makes efficient use of the keyboard an issue. Since time spent in keyboarding/typewriting instruction and practice during the school day has--at the least--no ill effects on academic achievement, concern about scheduling constraints may be alleviated. (Six tables of data and four figures are included. A 55-item bibliography is attached.) (SAM)

Effects of Keyboarding/Typewriting on the Language Arts Skills of Elementary School Students

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Abstract

Forty-one research studies completed between 1929 and 1983 were identified as addressing the effects of typewriting on language arts skills. Information about each of the studies was entered in a Lotus 1-2-3 database containing 43 fields. Effect sizes were calculated for 21 studies. The evidence collected suggests a small positive effect of the use of typewriters on reading, word identification, syntax, and spelling skills and a greater potential effect on writing. Subjective reports favored the typewriter as a motivating tool. Students in the primary grades can be expected to profit the most from typing; touch typing appeared little different from use of the hunt and peck method.

With increasing access to computer applications software, efficient use of the keyboard is an issue. Since time spent in keyboarding/typewriting instruction and practice during the school day has--at the least--no ill effect on academic achievement, concern about scheduling constraints may be alleviated.

Effects of Keyboarding/Typewriting on the Language Arts Skills of Elementary School Students

The use of computers in the classroom expanded dramatically during the 80's. In a survey of over 2000 schools across the United States, Becker (1986a, 1986b) reported a fourfold increase in the number of computers and a threefold increase in the number of students using computers during the two-year period from 1983 to 1985. Drill and practice programs dominated the design of early software. Becker, however, identified the growing use of applications software, including word processing and database programs. A 1989 survey (Becker, 1990) of 1416 schools and over 3000 teachers in the U.S. affirmed these trends. While drill and practice programs require minimal keyboard entry by students, keyboarding skills are important to the efficient use of applications software (Wetzel, 1985).

Such changes find teachers, supervisors, and administrators assessing the need for keyboarding instruction. A survey (Borthwick, 1986) of educators at an Ohio statewide computer conference showed almost two-thirds of the respondents thought keyboarding/typewriting instruction should begin in or before fourth grade. Yet half of the survey respondents expressed time and scheduling constraints in implementing such instruction. Should such instruction take place during the school day?

Needs assessment committees require input on which to base instructional decisions. If the teaching of keyboarding/typewriting has a positive effect--or at least no ill effect--on academic skills, concerns about scheduling constraints may be alleviated. In an effort to provide such input, this study summarizes research on the effects of keyboard use and instruction on the language arts skills of elementary school students. While Anderson-Inman (1990) points out that "keyboarding instruction has been an important issue for teachers ever since the first computer entered public school," (p. 34), keyboarding studies began long before the use of electronic keyboards.

Method

Research Studies Reviewed

Forty-one research studies completed between 1929 and 1983 were identified as addressing the effects of keyboarding/typewriting on language arts skills. These studies met the following requirements: (1) form or design indicated an effort to complete a controlled experiment; (2) the experiment examined the effect of typewriting (independent variable) on language arts skills (dependent variables); and (3) subjects studied were in grades one to six.

Six indexes were consulted in the search for relevant studies: Business Education Index, Education Index, Comprehensive Dissertation Index, Master's Abstracts International, Index to Research in Business and Office

Education (Rahe, 1974), and Index to Doctoral Dissertations in Business Education (Rahe, 1975). In addition, computer searches were completed using ERIC and Dissertation Abstracts data bases. The research studies reviewed were Master's theses (22%), doctoral dissertations (34%), and other research studies (44%). Of these, 15 studies (37%) were not identified as being published.

The research studies selected for review used typewriters rather than computers for instruction and classroom application. More recent literature involves computers but often focuses on the need for keyboarding instruction in an information-based society, the techniques of keyboarding instruction (traditional v. computer-assisted instruction), and instructional materials (games v. drill and practice software).

The relevant studies included for review should be considered as a sample of a population of studies. Jackson (1980) cautions that even if all of the available studies were located, they would not cover all of the phenomena which could be studied. Findings that are consistent across a variety of study designs, however, may be regarded with greater confidence.

Data Analysis

Information from each of the research studies was entered into a Lotus 1-2-3 database containing 43 fields or categories. (See Table 1.) Formation of

the database enabled sorting of research studies according to a number of variables, such as treatment using touch typing, instructor characteristics, materials typed, or effect size. A printout of a particular field, such as hours of formal instruction, could also be arranged (sorted) according to effect size.

Insert Table 1 about here

Effect Sizes

No study reviewed herein presented an effect size as determined by its author(s). Effect sizes were computed by this author for 21 studies. Final status scores were used to compute effect sizes for 13 studies using the formula (Glass, McGaw, and Smith, 1981):

$$\frac{\bar{X}_E - \bar{X}_C}{S_C}$$

The remaining effect sizes were estimated based on gainscores, covariance-adjusted scores, t values, or F ratios (Glass, McGaw, and Smith, 1981). When possible, effect sizes were also computed for the following language arts skills: reading, word identification, syntax, and spelling.

Author-reported effects (significant positive to significant negative) were compared with effect sizes derived for this review. In four cases, several methods of computing effect size were tried and the effect sizes best reflecting author-reported results selected. For example, effect sizes computed from final status scores did not reflect Brion's Year 1 (1961) reported results as well as gain scores did. Therefore, gain scores were selected for computing a more accurate effect size. This assumes that original authors analyzed and interpreted their data correctly.

Researchers differ about whether or not poorly designed studies should be included in a review. In an effort to consider the possible correlation of poor design with effect size, an abbreviated evaluation of design quality considered: (1) blinding of experimenter (accessibility of instructor to information about experimental or control group assignment as well as any relationship with subjects), (2) sample size mortality, (3) assignment of subjects to groups, and (4) reactivity of outcome measures (ease of influence by researcher, instructor, or subject). No correlation was found.

Rationale for not estimating effect sizes for the remaining 18 studies included: lack of control group, incomplete statistical data, and/or use of school grades or grade-equivalent scores as outcome measures. Variables and outcomes of studies without effect sizes were, however, considered in the

literature synthesis; see, for example, study outcomes determined through vote counting below.

Visual Displays

Lotus 1-2-3 was used to prepare tables and graphs which might illuminate important variables. The goal was to establish the conditions under which the treatment had the greatest (if any) effect. Visual displays also helped to identify outliers and suggest predictable relationships (Light and Pillemer, 1984).

Synthesis of the Literature

Study Designs

In general, the design of studies in this review included: students in several grade levels, the use of matched groups, the control group involved in "regular" school activities, treatment during a period of nine months, instruction by the regular classroom teacher, and integration of typing practice/use by the experimental group in the language arts program.

Sample groups were students in grades one through six. Grades four to six were more often selected as all or part of the sample group. Sample sizes for the 41 studies varied greatly, ranging from 6121 (Wood & Freeman, Year 1, 1932) to six for Heyman (1983) who used a case study approach. The median sample size was 56. Eighteen of the studies had sample groups with

special characteristics: above-average ability, below-average ability, students with reading problems, and bilingual students. All but one of the studies was completed in the United States; Malmquist (1962) used students in four classes of the National School for Educational Research in Linkoping, Sweden.

Several fields of the database contain treatment variables including program type, typing method, typing text, characteristics of typing instructor, and hours of typewriter instruction and use. The majority (66%) of studies emphasized a touch typing approach. Programs with minimal instruction were labeled as hunt and peck and often included limited instruction on hand placement--left hand on left side of keyboard, right hand on right side of keyboard--and use of the thumb on the space bar. Some authors indicated that typing instruction was similar to that of a high school typing class (Granstaff, 1968; Rowland, 1929; Schimmelpfenning, 1960; Sorgatz, 1964). Sorgatz mentions the use of instructor dictation, tape recordings, records, rear-view and overhead projection--all suggesting a very formal approach to teaching touch typing.

Burke's 1939 method of teaching touch typing to second graders involved a combination of the psychomotor and cognitive domains. Students wore rings on each finger. An animal picture on each ring corresponded to a

picture on a typewriter key. Students memorized rhymes describing each animal key and the letters they produced.

> Little Birdies you can see
>
> perched on g and a and z. (Burke, 1939, p. 42)

Hours of instruction, practice, and typewriter use varied considerably, as did availability of machines. While Conard (1935) instructed students not to practice typing at home, other researchers encouraged students to borrow machines to take home over weekends (Erickson, 1960; Krevolin, 1965; Sorgatz, 1964; Tootle, 1961). Virtually every study in this review included some typing of language arts material.

The language arts skills tested by the experimental studies were identified by over 30 different terms. For the purposes of this paper, six main language arts concepts were selected. Reading, for example, was used for: comprehension, fact material, organization, central thought, oral reading, beginning reading, word phrase and sentence meaning, reading completion, sentence reading, and paragraph meaning. Work study skills included: following directions, reading of directions, listening skills, and rate of reading.

Several studies limited typing instruction to a particular area within the language arts curriculum:

Author	Year	Subject Area Emphasized
Bernazza et al.	1970	Reading
Burke	1939	Reading
Campbell	1973	Reading
Forester	1934	Creative Writing
Muir	1970	Spelling
Singh et al.	1977	Spelling

Bernazza, Bloomer, and Cline (1970) used a 25-lesson workbook in a first grade year-long reading-typing program. Each lesson focused on a single phoneme. Krevolin (1965), Tootle (1961), and Sorgatz (1964) each mention some emphasis on "thinking at the typewriter" by composing rather than copying previously written material.

A wide range of evaluation instruments was used in the studies. Authors frequently used pretests, both intelligence and achievement, to match experimental and control pairs or groups. Often, the same achievement test (alternate form) was given as a post test. Some researchers gathered data with a variety of instruments including achievement tests, pupil questionnaires, grades, and teacher interviews.

Study Outcomes

Vote Counting. Light and Pillemer (1984) outline a number of ways to sum up the effect of a treatment. One quick and easy method is to count "votes," one per study, to see if the treatment is effective. Of the 41 studies reviewed, 21 found some significant positive effects related to language arts. Only three studies found significant negative effects. As illustrated in Table 2, another vote count might consider significant positive effects on specific language arts areas.

Insert Table 2 about here

While creative writing had the largest percent of studies with positive effects, it also had a smaller number of studies reporting (10). Evaluation of creative writing was based on a variety of criteria (e.g. quality, quantity, use of varied sentence patterns) and methods. This may make assessment of gains across a variety of studies more difficult. Other categories of language arts skills were often measured using standardized tests. Objective data did not suggest any effect on work study skills, but subjective reports favored the typewriter as a motivating tool.

Pooling of Effect Sizes by Concept. Another method for considering effects of typewriting on language arts skills involves pooled effect sizes. Median scores were selected for pooled effect sizes. This was to prevent outliers from unrealistically raising or lowering pooled scores (Slavin,1986). Pooled scores by concept were:

Concept	Pooled Effect Size
Reading	.16
Word Identification Skills	.17
Syntax	.12
Spelling	.15

The above pooled effect sizes represent a small positive effect of typewriting on selected language arts skills. Reported quantitative data for work study skills and creative writing were too limited to estimate effect sizes.

Table 3 summarizes pooled effect sizes by concept area and grade level.

Insert Table 3 about here

Largest effect sizes by grade level were:

Concept Area	Grade Level
Reading	2
Word Identification Skills	2
Syntax	3, 4
Spelling	1

It would appear that in the areas of reading, word identification skills, syntax, and spelling, the treatment was more effective for students in the primary grades (grades 1-3).

Study Outcomes (Effect Sizes) as Related to Selected Program Characteristics

While the database presented the opportunity to examine many relationships, program characteristics considered within the limitations of this review were: typing method, hours of typewriter use, hours of formal instruction and practice, length of study in months, grade level of subjects, pupil-machine ratios, and characteristics of typing instructor. Methods used to draw conclusions involved sorting database categories according to effect size (see Table 4) and creating bar graphs or scatter graphs (see Figure 1).

Table 4 lists studies in order by effect size and includes a brief description of typing method. Seven studies did not emphasize formal typing skills. Effect sizes suggest that the use of a typewriter, whether with hunt and

peck or touch typing instruction has a positive effect more often than it has a negative effect. Sixteen studies had a positive effect while five exhibited a negative effect.

Insert Table 4 about here

Since many of the studies involved integration of typing skills with classroom activities, hours of use could be quite different from hours of instruction/ practice. Muir's (1970) treatment, for example, included 33 hours of formal instruction plus the typing of 66 spelling lessons. Amount of time spent sometimes had to be estimated from author-reported information such as lesson length and study length. Figure 1 is a visual display of the relationship of hours of formal instruction/practice to effect size. The scatter graph plots a point for each study based on its coordinates for hours of formal instruction/ practice and effect size.

Insert Figure 1 about here

The circled area on Figure 1 denotes a cluster of studies. The number of studies found within the circle suggests that the amount of formal instruction/practice was not related to effect size. This supports previously discussed evidence suggesting method used (hunt and peck v. touch typing) did not seem to directly influence effect size.

Outliers (beyond the circle) on Figure 1 include Karnes, Clarizio, and Zehrbach (1964) and Bernazza et al. (1970); both were high in hours of instruction/practice. Bernazza et al. conducted a year-long study using an integrated typing-reading program emphasizing a phonetic approach with first graders. Karnes et al. (1964) is high in hours of instruction/practice but falls near the cluster for effect size. This can perhaps be explained by the sample who were students aged 10 to 13 identified as educable mentally handicapped. Campbell (1973) and Singh, Brosier, and Smith (1977) used no formal instruction/practice. Their sample groups, in contrast to Bernazza et al., were learning disabled students.

Figure 2 illustrates the relationship of hours of typewriter use to effect size. Total hours were estimated when not directly reported. Karnes et al. (1964), Bernazza et al. (1970), Campbell (1973) and Singh et al. (1977) appear, once again, as outliers. Removing all six studies which fall outside the circle, no relationship between hours of typewriter use and effect size is found

(r=-.0066). Of the outliers, only Malmquist (ES=-.19) and Bernazza, et al. (ES=.66) had sample groups without special characteristics. When scores for Malmquist and Bernazza, et al. are added to the analysis, r is .57 and is significant ($p < .05$, $df = 15$).

Insert Figure 2 about here

Figure 3 provides a visual display of the relationship of study length to effect size. Determining length of studies in months required estimation in some cases. For example, Karnes et al. (1964) began their study with a sample of 13 pairs; nine additional pairs were added a year later. A range of 18 to 27 months was averaged to produce one entry of 22.5 months. On Figure 3, a line of studies is found at the Y axis nine-month duration. These nine-month-long studies have a range of effect sizes moving well across the graph from -.08 (Sorgatz, 1964) to .66 (Bernazza et al., 1970). The range for nine-month studies suggests no particular relationship between study length and effect size.

Insert Figure 3 about here

Karnes, Wollersheim, and Stanley (1963) appears as an outlier in Figure 3. The sample used by Karnes et al. (1963) were gifted students in grades four to six. When compared with Yuen, Carrillo, Bjonerud, and Chambers (1962) and Sorgatz (1964) who used samples with above-average ability, no special pattern is apparent.

Author	Grades	Length of Studies	ES
Karnes et al. (63)	4,5,6	27 months	-.01
Sorgatz	6,7	9 months	-.08
Yuen et al.	4	9 months	.35

Figure 4 displays the relationship of grade level and effect size. The pattern in Figure 4 supports earlier conclusions based on Table 3. Treatment (use of typewriting) appears to have a larger effect in the lower grades.

Insert Figure 4 about here

Similar use of tables and graphs considered pupil:machine ratio and characteristics of typing instructor. Larger effect sizes (.12 to .95) were found for studies with pupil:machine ratios of 1:1 or 2:1. Smaller effect sizes (-.17 to .10) had larger numbers of pupils per machine (7:1, 5:1, 4:1, 3:1). Elementary classroom teachers were most often instructors in the studies

reviewed. Sometimes, the researcher--who was often a business educator--taught the class. However, no relationship was found between effect size and type of instructor.

Discussion

Keyboarding/typewriting may assist language arts skills by providing clear visual display of letters, punctuation, and capitalization; developing skill in keeping one's eye on a line of print and in progressing from left to right across a page; making lower-upper case connections; and encouraging authentic language arts activities. Along with ease of making letter forms (keystroke v. hand writing), such influence may explain the greater effect of typing on the language arts skills of students at the primary level.

Overall, this review found only small gains in language arts skills, with recommendations for further research related to effects on creative writing. Effect sizes computed for 21 studies ranged from -.19 to .95. Effect sizes for eleven studies were between 0.06 and .66; three of these were after-school or summer programs, the rest were programmed into the school day. The largest effect sizes (.95, .88,) were from studies identified as outliers on several scatter graphs; these studies involved samples with special characteristics. Five studies had small negative effect sizes (-.01, -. 06, -.08, -.17, -.19). Weier, (1981, ES=-.17) studied fifth and sixth grade children attending a summer

program for children of migrant families. Malmquist's (1962, ES=-.19) treatment occured as part of the regular class activities of second and third graders attending a Swedish school used for educational research.

From the above, we can assume small positive gains related to the use of typewriting/keyboarding by elementary school students. Are such gains adequate to justify keyboarding instruction during the school day? Muir (1970) states: "It is significant to note that the experimental pupils did not suffer any academic loss between classes even though part of their school time was devoted to learning and to developing the skill of typewriting" (p. 169). Muir's (1970, ES=.34) treatment included the use of a high school text for typing instruction as well as typing used with 66 spelling lessons to increase the amount of spelling practice.

Muir as well as Artuso (1961) and Malmquist (1970) comment on the need to carefully consider the material to be typed. Table 5 lists studies with larger effect sizes (over .3) or with larger author-reported significant positive outcomes. Each of these studies meets Slavin's criteria for inclusion as best-evidence (Slavin, 1986). The treatment category considers emphasis on typing language arts materials. The amount of language arts emphasis needed for effecting improvements in language arts skills through typewriting/

keyboarding is not clear from the outline of the five treatments for these five studies.

Limitations related to the methodological aspects of this paper include its emphasis on the quantitative information provided by the research studies included for review. Reliance on results of standardized tests to compute effect sizes emphasizes a "bottom-up" orientation, viewing language arts as consisting of many isolated subskills. Goodman (1975) cautions, "Testers have followed an incorrect model partly because of the atomistic focus of many learning theorists that starts with parts and builds up to the whole" (p. 628). While the studies included for review may or may not have used an integrated approach to language arts instruction, most relied on standardized tests of subskills to measure student gains.

Conclusions

With increasing access to computers and use of computer applications software, especially word processing, correct and efficient use of the keyboard is an issue. This study summarizes what has been learned in the past to enable informed decision-making in the classroom. This review of the literature found that the time spent in keyboarding/typewriting instruction and practice during the school day probably has--at the least--no ill effect on academic

achievement. This provides one rationale for scheduling keyboarding instruction during the elementary school day.

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Table 1

Fields of Lotus 1-2-3 Database on Keyboarding/Typewriting

Cell Address	Field Name
A1	Author
B1	Year
C1	Type
D1	Published
E1	Grade
F1	Significant Positive Effect
G1	Positive Effect
H1	No Effect
I1	Negative Effect
J1	Significant Negative Effect
K1	Expressed New Focus of this Study
L1	Control Group Size
M1	Experimental Group Size
N1	Matching of Control/Experimental Groups
O1	Location
P1	Characteristics of Experimental Group
Q1	Characteristics of Control Group
R1	Program Type
S1	Typing Method
T1	Typing Text
U1	Treatment: Experimental
V1	Treatment: Control
W1	Integration in Academic Areas
X1	Characteritics of Typing Instructor
Y1	Type of Machines
Z1	Pupil:Machine Ratio
AA1	Hours of Typewriter Use
AB1	Hours of Formal Instruction/Practice
AC1	Length of Study
AD1	Length of Study in Months

(table continues)

Table 1 (continued)

Fields of Lotus 1-2-3 Database on Keyboarding/Typewriting

Cell Address	Field Name
AE1	Evaluation Instruments: Pre-testing
AF1	Evaluation Instruments: Post Testing
AG1	Type of Statistical Data
AH1	Effect Size
AI1	Conclusions
AJ1	Grade:GWPM Achieved
AK1	Recommended Grade Level
AL1	Reference to Handwriting
AM1	Recommendations for Further Study
AN1	Funding
AO1	Equipment Provided By:
AP1	Expressed Limitations
AQ1	Reviewer Reactions

Table 2

Vote Count of Studies with Significant Effects on Language Arts Areas

Concept	Number of Studies Reporting Results	Percent of Studies with Significant Positive Results	Percent of Studies with Significant Negative Results
Reading	31	19%	0%
Word Identification Skills	28	18%	0%
Work Study Skills	5	0%	0%
Syntax	21	19%	.05%
Spelling	32	13%	0%
Writing	10	60%	10%

Table 3

Median Effect Sizes for Selected Concepts by Grade Level

	Median Effect Sizes			
Grade	Reading	Word ID	Syntax	Spelling
1	0.18	0.35		1.50
2	1.13	0.76		0.76
3	0.05	0.17	0.29	0.10
4	0.16	0.14	0.29	0.17
5	0.10	0.18	0.04	0.15
6	0.10	0.07	0.10	0.06

Table 4

Studies Sorted According to Effect Size and Listing Method of Typing Used

Author	Effect Size	Typing Method
Campbell	0.95	hunt and peck
Singh, et al.	0.88	hunt and peck
Bernazza, et al.	0.66	touch typing
Yuen, et al.	0.35	touch typing assumed
Muir	0.34	touch typing
Spencer-Part B	0.30	hunt and peck
Beavers	0.25	touch typing
Unzicker	0.21	hunt and peck
Tootle	0.21	touch typing
Spencer-Part A	0.20	hunt and peck
Sinks & Thurston	0.19	touch typing assumed
Karnes, et al. (64)	0.14	touch typing based on associative learning
Grindberg	0.12	touch typing
Artuso	0.10	touch typing
Salem	0.07	touch typing
Wood & Freeman, Yr. 1	0.06	hunt and peck
Karnes, et al. (63)	-0.01	touch typing assumed
Brion, Yr. 1	-0.06	hunt and peck assumed
Sorgatz	-0.08	touch typing
Weier	-0.17	touch typing
Malmquist	-0.19	touch typing assumed

Table 5

Instructor and Emphasis on Language Arts of Best-Evidence Studies

Author	Method	Instructor	Treatment
Artuso	touch	classroom teacher	typed variety of class assignments
Bernazza et al.	touch	classroom teacher	typing as part of reading program; 25 lessons, each on one phoneme
Burke	touch	classroom teacher	typing text with 100 most frequently used words; variety of class assignments
Prunty	touch	(unknown)	regular daily typing classes
Wood & Freeman, Year 1	hunt & peck	classroom teacher	typed variety of class assignments

Figure Captions

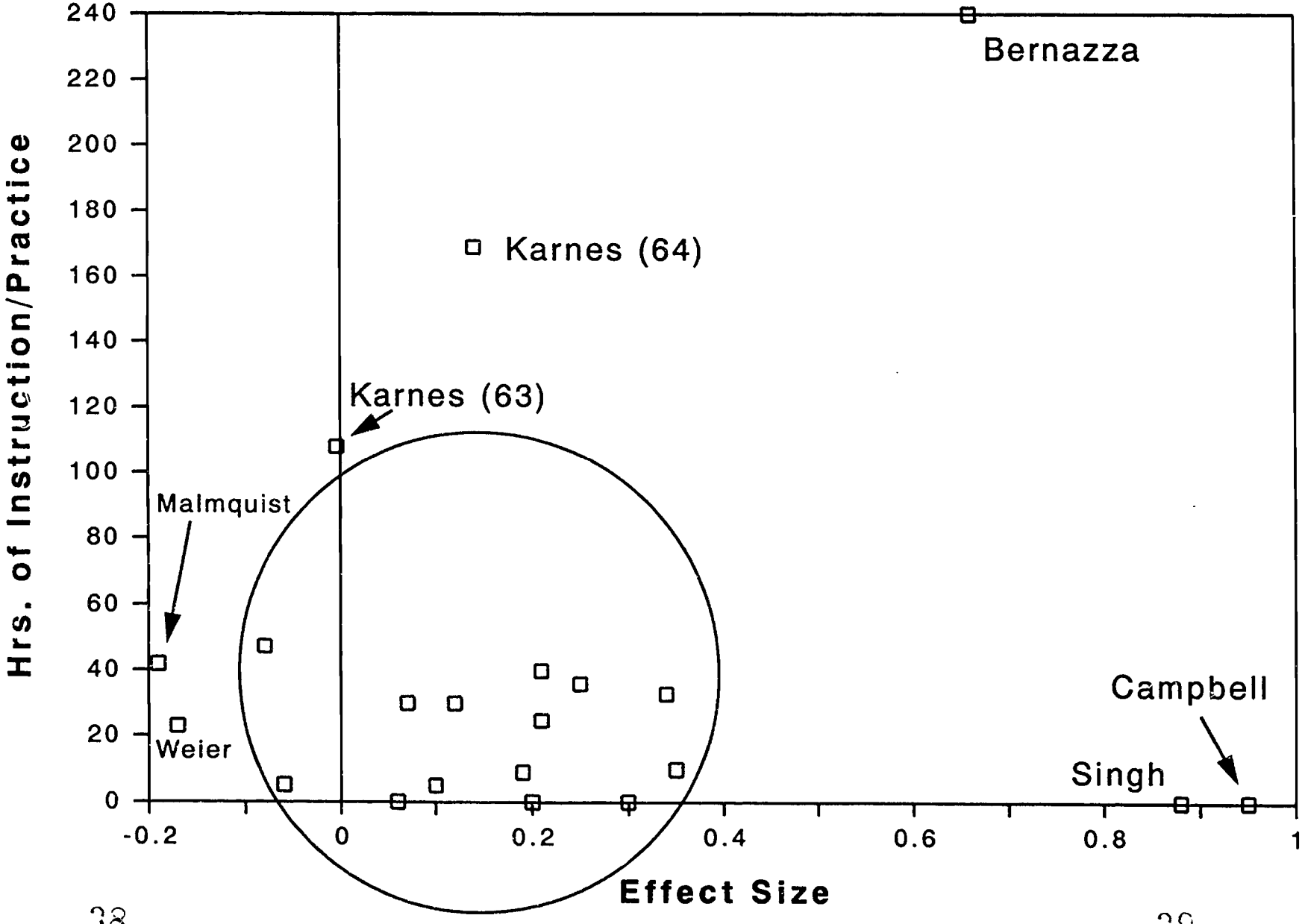
Figure 1. Relationship of hours of instruction/practice to effect size of treatment.

Figure 2. Relationship of hours of typewriter use to effect size of treatment.

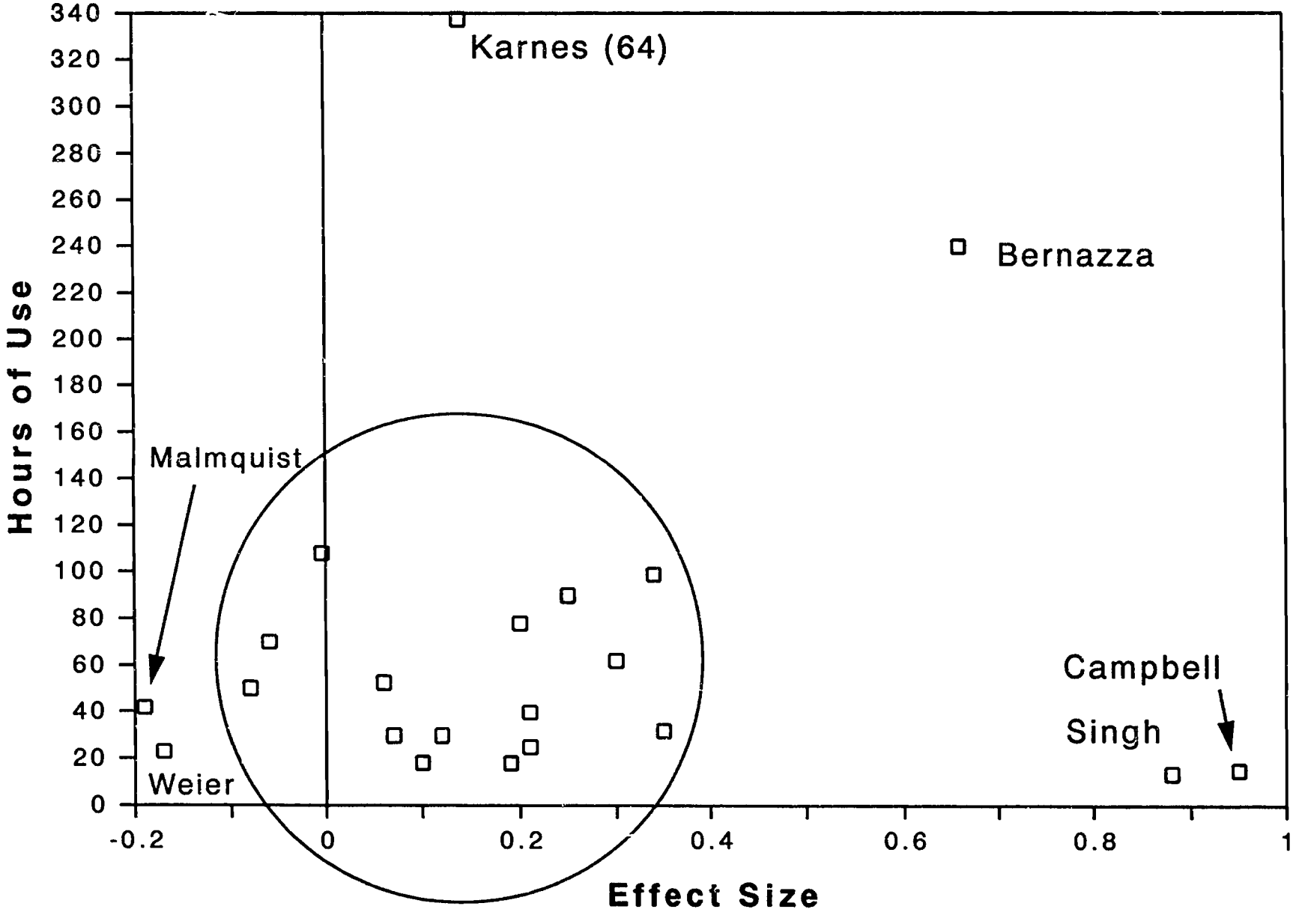
Figure 3. Relationship of study length to effect size of treatment.

Figure 4. Relationship of grade level of sample to effect size of treatment.

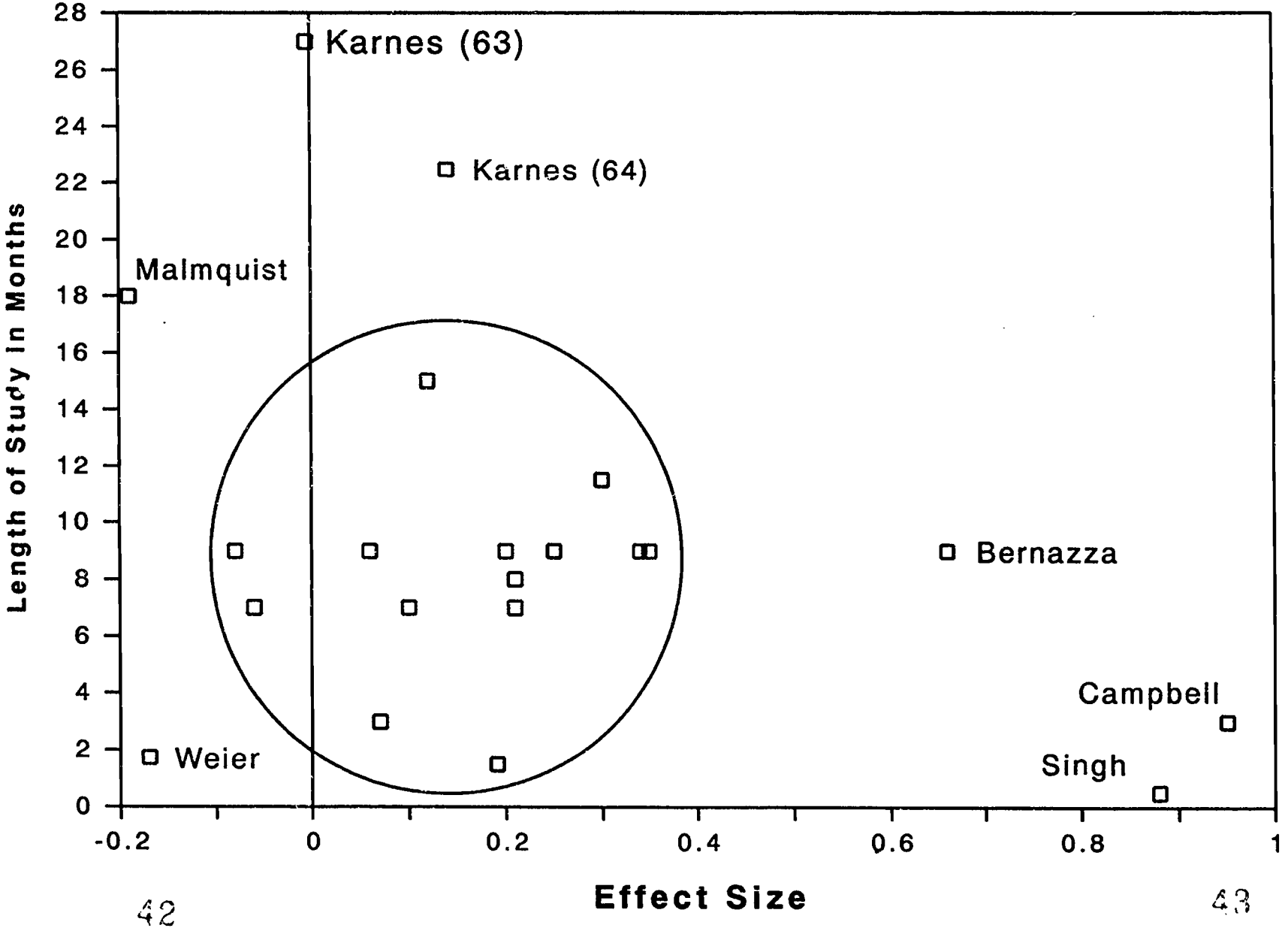
Relationship of Instruction/Practice to Effect Size of Treatment



Relationship of Hours of Typewriter Use to Effect Size of Treatment



Relationship of Study Length to Effect Size of Treatment



Relationship of Grade Level to Effect Size of Treatment