THE EFFECT OF COMPUTER USE AND LOGO INSTRUCTION ON THIRD

AND FOURTH GRADE STUDENTS' PERCEIVED CONTROL

by

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(ABSTRACT)

In this study, the effect of computer use and Logo
instruction on students' perceived control of computers and
generalized perceived control was examined.   Third and
fourth grade students ($\underline{N}$=90)   in four intact groups,
consisting of one treatment and one control group for each
grade level, were pre- and posttested, using the computer
control survey (CCS) and the Children's Nowicki-Strickland
Locus of Control Scale (CNS-IE).   A posttest measure of Logo
achievement was obtained from the treatment students.

Three way analyses of covariance, using the pretest
scores as the covariate, were used to test for differences
between the means of the independent variables group, grade,
and gender for the dependent measures CCS and CNS-IE.
Comparisons of adjusted posttest scores on these variables
indicated that no significant differences existed between
the groups.   A linear association was found between Logo
achievement and the children's perceived control of
computers.   Selected reliable items from the CNS-IE
correlated with Logo achievement, although the full 40-item
instrument did not.

It is suggested that Logo instruction leading to Logo programming experiences may not produce in the children a sense of perceived power concerning the computer, nor lead to generalized LOC differences. Future researchers in this domain are advised to control for the internality of the sample and for the children's prior computer experience. Attention to the age/cognitive level of the sample, and length of treatment are suggested.

DEDICATION

I would like to dedicate this work to my parents,

            , who devoted their lives to better education.
They were my example.

                         and

My wife   ,   who gave me love and support when it
was needed.

                         and

My son   , and my daughter   . They are my
hope and joy.

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Précis

Locus of control may be defined as the degree to which

children perceive that reinforcement follows from their own

behavior (Rotter, 1966). Locus of control orientations are

said to be more internal if children perceive that they have

power over what happens to them. Conversely, a perceived

lack of power to control reinforcement is termed a more

external orientation. Internality has been associated with

a variety of school-related achievement and competence

behaviors (Bar-Tal & Bar-Zohar, 1977; Nowicki & Strickland,

1973).

Computer use in schools offers the potential for

children to control their immediate environment. Seymour

Papert (1980) refers to the need to take advantage of this

potential, and speaks of a generalized "empowerment" as a

desired effect of putting the control of the computer in the

child's hands. The degree of control available to children

working with computers varies with the instructional

environment that is implemented. When computers are

provided in an exploratory context, such as is possible in

programming, children's feelings of control may be enhanced

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(Luehrmann, 1980; Mullan, 1984; Papert, 1980; Raphael, 1976). Riordan (1982) and Watt (1982) both refer to a design emphasis of the educational computing language Logo to be such that it "places the learner in charge." In Harvey's (1985) words, "empowerment means programming" in educational computing and Logo is a programming language which is suitable for use by young children.

The literature suggests that computers may greatly affect students' attitudes (and behaviors) in positive ways (Fisher, 1984). Much of the data that relates to this claim, however, is anecdotal. Quantifiable data are needed to assess adequately the affective effects of computer use on students.

The focus of this research was on whether or not third and fourth grade students, given the opportunity to interact in a computer environment characterized by exploration and discovery, would develop positive individual feelings of personal control over the computer. In addition, this study examined whether or not this computer intervention would have an effect on children's perceptions of personal control over their environment in a more generalized sense.

Specifically, three research questions were addressed in this study: (1) would computer use and instruction with the Logo programming language contribute to the children's

greater senses of perceived control over computers; (2) would computer use and instruction with the Logo programming language contribute to a greater sense of generalized perceived control by the children; and (3) would a linear association be found to exist between the treatment students' Logo achievement scores and their a) perceived control of computers, and b) perceived locus of control.

A computer control survey (CCS) was created and used to measure perceived control of computers, and a Logo quiz was developed to measure the students' Logo achievement. The Children's Nowicki-Strickland Internal-External Locus of Control Scale (CNS-IE) was chosen to provide a measure of the students' generalized perceived senses of control.

Three-way analyses of covariance were used to test for differences between the means for the independent variables of group, grade, and gender, using the pretest scores as the covariate.

Comparisons of the adjusted posttest scores for each of the independent variables on the CCS indicated that the differences between the groups were not statistically significant. Similarly, comparisons of the adjusted posttest scores of each of the independent variables on the CNS-IE indicated that the differences between the groups were not statistically significant. A linear association

was found to exist between the children's Logo achievement, as measured by the Logo quiz, and their perceived control of computers, as measured by the CCS. Selected reliable items of the CNS-IE were also found to correlate well with Logo achievement, although the full 40-item CNS-IE did not correlate significantly with the children's Logo achievement scores.

The Logo treatment did not produce the hypothesized changes in the children's perceived control of computers and locus of control. The internality of the sample, the students' prior experience with the computer, the young age/cognitive level of the children, and the short intervention period may have contributed to the nonsignificant findings. It is suggested that Logo instruction leading to Logo programming experiences may not produce in children a sense of perceived power concerning the computer, and may not produce generalized differences in locus of control. It is recommended that researchers for future studies lengthen the treatment period, control for prior computer experiences, and provide for more cross-grade cross-school representation in the samples.

THE EFFECT OF COMPUTER USE AND LOGO INSTRUCTION ON
THIRD AND FOURTH GRADE STUDENTS' PERCEIVED CONTROL

When a subject perceives a task to be under
his own control, he is likely to be more alert to
those aspects of (his) environment which provide
useful information, take steps to improve his
environmental condition, place greater value on
skill or achievement . . . . (Rotter, 1966, p. 25)

Locus of Control

As a psychological construct, locus of control was
developed by Rotter (1954, 1966) as part of his social
learning theory. According to this theory, people enter a
situation with certain expectancies regarding the probable
outcome of their behavior. The frequency of a particular
behavior is greater if past experience indicates that a
reward will be the result. Conversely, if experience
indicates to them that the result of their actions will be
nonrewarding, the frequency of a particular behavior
decreases. Expectancy and reinforcement are therefore
brought together in a working construct. A determinant
within this framework is the degree to which persons feel
that they possess or lack power over what happens to them.
In other words, reinforcement may be perceived as contingent

upon one of two factors: (1) their own behavior or attributes, indicating belief in internal control; or (2) outside forces that may occur independently of their actions, thus indicating a belief in external control.

Persons exhibiting internal locus of control think of themselves as being responsible for their own behavior. They see their own efforts and abilities as causes of their successes and failures (Lefcourt, 1966; Phares, 1976; Rotter, 1966). They will accept praise as deserved for their accomplishments and blame themselves for their failures. They perceive themselves as being masters of their immediate environment.

Individuals exhibiting external locus of control see events as being controlled by outside forces, such as fate, chance, hope, and "powerful others" (Lefcourt, 1966; Rotter, 1966). They perceive their behavior as being irrelevant to observed outcomes. To them, blind luck and circumstances beyond their control seem to impact heavily on their behavior. Success does not seem to them to be the result of their own efforts, and they do not exhibit a sense of control with respect to their environment.

Research on Locus of Control

There are reports from a vast body of research which use the locus of control (LOC) construct. Rotter (1975)

indicated that more than 600 studies had been conducted by
the early 1970's and that interest in the topic as a subject
for psychological investigation was active, if not
increasing. The early investigations were done in
university settings using available adult subjects and, as a
result, the instruments produced were necessarily for adult
use. Strickland (1972) indicated that LOC researchers had
been interested in relating the LOC variable to children's
academic and social behaviors almost from the beginning. To
provide an LOC measure for children, creative variations of
the adult scales were constructed.

Early Investigations

Phares (1957) and James (1957) began the foundational
LOC research at the Ohio State University under the
direction of Julian Rotter. Much of this work was in the
area of the effect of skill versus chance perceptions upon
performance. In both the James and the Phares studies, the
same task was described as a skill task to one group and as
a chance-related task to a second group. The subjects'
verbal expectancies regarding probable reinforcement were
found to be significantly affected. The subjects that had
been informed that the task success was a matter of chance
had less expectancy than the skill group. According to
Strickland (1973b), these results demonstrated that what

persons are led to believe about the locus of control of reinforcement has a definite impact upon their perceptions and behavior. This insight led to considerations concerning whether or not it may be said that people have a generalized expectancy about control of reinforcement.

A series of assessment instruments were developed by James and Phares to determine if the subjects believed that events in their lives were under their personal control, or dependent upon powerful others, fate, luck, or chance. The research that emanated from work with these instruments indicated that an internal LOC orientation seemed to be associated with mastery and competence behaviors (Lefcourt, 1972; Strickland, 1973b; Strodtbeck, 1958).

Children's measures of locus of control

Bialer (1961) developed a children's LOC scale based on the James-Phares model. He used the scale with normal and mentally retarded 6- to 14-year-olds and found internality to correlate with a willingness to delay gratification in favor of subsequent, more valuable rewards. Strickland (1972), however, indicated that validity and reliability measures were inadequate in this scale.

Crandall, Katkovsky, and Crandall (1965) developed a children's scale called the Intellectual Achievement Responsibility Questionnaire (IARQ). This instrument

measured LOC strictly as it related to intellectual achievement situations. The focus of the IARQ was on measurement of LOC beliefs as they related to significant others, such as parents, teachers, or peers. In addition, the instrument introduced subscales which measured separately the individual's perceived responsibility for successes and failures. It continues to be used as an LOC measure specific to intellectual-academic achievement.

One of the more recent children's scales to evolve was the Children's Nowicki-Strickland Internal-External Locus of Control Scale (CNS-IE). To build construct validity, attention was given to Rotter's conception of LOC in the item formulation of this measure. Nowicki and Strickland (1973) have provided substantial reliability and validity evidence for this measure of generalized expectancy for control in children (see method section).

School-related investigations

Educational research using the LOC construct has become more evident in the literature as instruments for children have been developed. While it is recognized that correlational studies may sometimes be confounded by such factors as the socioeconomic status (SES) and ethnicity of the sample -- and that causality is always a problem -- these findings, when viewed in toto, seem quite consistent.

As such, they are potentially valuable in helping one understand the importance of LOC research in education.

Academic achievement studies. Generally speaking, school-age internals have been found to score higher on a variety of achievement tests, have higher grade point averages, and utilize information more efficiently than their more external classmates (Shaw & Uhl, 1971; Stipek & Weisz, 1981). A major study linking LOC with school achievement was the prestigious Coleman Report (Coleman, Campbell, Hobson, McPartland, Mood, Weinfeld, & York, 1966). Using an early Rotter scale, this report did much to establish the importance of the student attitude factor which it referred to as the extent to which an individual feels that he has some control over his own destiny. The committee used this LOC measure in a survey of over 645,000 school children. In the conclusions of this nationwide survey, the committee singled out one factor, the student perceived control factor, as having a "stronger relationship to achievement than all the 'school' factors put together" (p. 22).

Bar-Tal and Bar-Zohar (1977), in a review of 36 studies, examined the relationship of LOC and school achievement. They found that only one of the studies showed a negative relationship, while 31 studies reported a

positive relationship between academic achievement and LOC (four reported non-significant findings).

Specific studies, including one by Nowicki and Strickland (1973), found that internality was significantly related to academic competence. Crandall, Katkovsky and Crandall (1965), McGhee and Crandall (1968), and Walberg and Shanahan (1983) reported significantly higher report-card grade averages and standard achievement test scores among elementary students who indicated greater internality. Interestingly, Nowicki and Roundtree (1971) found internal males receiving higher marks, but not females. Internal girls were significantly associated with involvement in extra-curricular activities.

Some achievement-related behaviors have also been correlated with LOC. Penk (1969) found 7- to 11-year-old internal children capable of greater levels of verbal abstraction. Crandall and Lacey (1972) found internality correlated with superior performance on the Witkin Embedded Figures Test (Witkin, 1950), indicating greater field independence. Gruen and Ottenger (1969) found in a third-grade sample that internals were capable of higher level strategy than third-grade externals in tasks requiring hypothesis testing.

Thus, an internally oriented locus of control appears
to be a variable that is closely related to academic
achievement. In addition, various achievement-related
behaviors appear to be linked to greater internality.

School behavior studies. A number of studies relate
LOC with school-related social and behavioral variables.
For example, internal school children have been found to
exhibit greater confidence, self-esteem, and efficacy in the
classroom (Nowicki & Strickland, 1973). Cone (1971)
reported internals as being more likely than externals to
behave in socially acceptable ways, and Gochman (1971) found
internal children to have greater independence and autonomy.

Student initiative, persistence, and various goal-
conscious behaviors also consistently appear to be related
to internality. Fanelli (1972) and Gozali, Cleary, Walster,
and Gozali (1973) reported that internal students tended to
work more systematically and efficiently, showing more rapid
improvement in serial tasks than externals did. Task
persistence was found by Gordon, Jones, and Short (1977) to
be related to internality with most of the groups of
elementary children that were tested.

Externality, on the other hand, has been associated
with students' antisocial and delinquent behaviors as well
as their lack of classroom adjustment or success. Bryant's

work (1974) suggests that externals are more likely to become behavior problems. Martin (1972; as cited in Strickland, 1972) found that teachers selected external children significantly more often than internals as classroom behavior problems. Juvenile delinquents were found to be more external when compared with non-delinquent boys and girls (Beck & Ollendick, 1976; Duke & Fenhagen, 1975). Similarly, more antisocial behaviors have been associated with external students in a study by Jessor, Graves, Hanson, and Jessor (1968). Reimanis (1970) indicated that external students showed a tendency to interfere with teacher attempts to increase achievement striving in the classroom. Lefkowitz and Tesiny (1980) noted poor school attendance, poor social behavior, and diminished popularity among students described as external. Walberg and Shanahan (1983) stated that externals may be expected to approach work with less enthusiasm, assuming failure in task situations. These collective studies seem to indicate that more positive, competence-centered, task-oriented classroom behaviors are associated with greater internality.

Examination of the LOC construct would seem to be of great potential benefit to education. An internal LOC, according to available research, is associated with more

positive personal, academic, and societal orientations than an external LOC. Conversely, externality appears to be associated with a poor self-image and antisocial, delinquent behaviors. A reasonable goal of educators, therefore, would seem to be to examine ways of affecting change in children's LOC orientation toward the internal.

Changes in locus of control

Lefcourt (1972) has suggested that a goal of psychotherapy should be to help patients develop an internal locus of control orientation. Smith (1970), using a six-week life-crisis resolution intervention, found that the clients shifted significantly toward the internal when compared with a noncrisis patient control group. A variety of school studies using widely different treatments and techniques have been employed in an attempt to accomplish such a change.

Stephens (1971) indicated that certain classroom philosophies seemed to facilitate greater internal growth in children. Specifically, "open" classrooms, such as the Montessori approach and parent cooperative schools, were found to give children a perception of greater personal control over events. Reimanis (1974) employed behavior modification techniques and counseling with third graders, significantly increasing internality in matched groups.

Edwards (1970-1972; as cited in Strickland, 1972) used a large scale elementary behavior modification program to internalize student LOC orientations. Baron and Ganz (1972) worked with the effects of feedback on task performance in lower socio-economic (SES) group black 10- and 11-year-old children. They found that when reinforcement (success feedback) was self-discovered, the internal children were more performance-motivated than the external children.

Nowicki and Barnes (1973) found that a structured camp experience resulted in significant internal shifts in inner-city youngsters. The camp experiences were thought to have given the children a greater feeling of being in control of events. Students who were in the camp experiences a longer time tended to continue the internal shift. These studies suggest that changes in LOC may be accomplished through classroom and clinical interventions.

Computer Use as an Agent of Change

Recently, research has indicated that the use of computers in schools may significantly affect student attitudes and behaviors (Becker, 1983b; Fisher, 1984; Kulik, Kulik, & Bangert-Drowns, in press). These findings, however, are of a largely anecdotal nature. Quantifiable data is noticably absent and has been requested in recent literature. Fisher (1984), for example, refers to a

desperate need for more research on the effects of different uses of computers on student attitudes. Kulik, et al. (in press) state that researchers have given almost no attention to the transfer of gains and interpersonal outcomes of classroom computer use. Ryba and Chapman (1983) indicate that little research is available concerning the effects of computers upon the manner in which students perceive their own abilities.

<p align="center">Control over the Computer</p>

Due to a lack of empirical data, claims regarding the affective gains of students engaged in classroom computing cannot be supported or challenged. One purported affective benefit of educational computing found frequently in the literature is that it allows students to feel "in control" (Markuson, Tobias, & Lough, 1983; Tipps, 1982; Watt, 1982). Luehrmann (1985) analyzes the student control concept in educational computing by making the distinction between application programs and learning to program the computer. Application programs "give the student only minimal control over the computer and few ideas about (the computer). Programming skills give complete control and deep ideas about (the computer)" (p. 24).

Ryba and Chapman (1983) observe that, "whether or not students are, in reality, able to exert control over

instruction may not be as important as the internal sense .
. . that they have of being in control" (p. 49). How
educators introduce computers to children, including the
environment and context within which they introduce them,
may well affect the children's sense of control.

Perceived control in an educational computing setting
is currently being examined by some investigators (Cook,
1986; Horner & Maddux, 1985; Louie, 1985b; Noss & Tagg,
1985; Ryba & Chapman, 1983). This interest is, in part, a
result of Seymour Papert's published concept of the
"empowerment" of children (1980) as a result of learning
programming with the computer language Logo. He states that
the child's developing "mastery over this space-age object"
(1984, p. 38) will result in the child "gaining a greater
and more articulate mastery of the world, a sense of the
power of applied knowledge . . . " (Papert, 1971, p. 1).

The Logo Programming Language

The spirit of Logo is to produce a language that
encourages an attitude of taking it and changing
it, shaping it to yourself . . . (Papert, 1983)

Seymour Papert and his research team at M. I. T. were
largely responsible for the creation and development of
Logo. Seeing computers used in schools to program or

"control" the child's activities, Papert sought to reverse the process and let the child control the computer by programming it. He viewed Logo as a potential vehicle with which this could be accomplished.

Logo is unique among computer languages in that it was developed as a learning procedure. Papert wanted to build a language and a learning environment that would take advantage of a child's natural learning process. He noted that children learn a considerable amount from personal experiences outside the school and that they learn best when they take an active, initiating role in building their own understanding of the world (Papert, 1980). In developing this learning language, he gave the students an "object to think with" (p. 11) - a little round-bodied robot called a "floor turtle." It could be made to roll over taped-down paper and to draw with a retractable pen according to programmed instructions. Students who were brought to M.I.T. as part of the Logo developmental project loved to manipulate the turtle and draw pictures with it. It became their object to think with and to control. Eventually, the robot turtle was developed into a screen turtle, for use directly on a computer monitor. The screen turtle became the object of student manipulation for the turtle graphics aspect of the Logo language.

Readiness Within The Logo Environment

The "entire context, made possible and managed by the teacher, in which students work with Logo" may be called the Logo environment (Riordan, 1982, p. 46). The children's readiness for working within this computerized environment is an important consideration.

According to Piaget (1968), the child's mind develops into the concrete operations stage between the ages of 8 and 11. In this stage, children begin to apply logical thought processes to concrete problems. As a result, they develop the ability to categorize events in terms of their causality (Piaget & Inhelder, 1969). During the concrete operations stage, the children may begin to make more consistent connections between the effects that the events of today have on the events of tomorrow. As children proceed through this stage, they may be more sensitive to transformations (Ginsburg & Opper, 1979), and better able to focus on the fact that their behavior can influence the outcome of events (Bachrach, Huesmann, & Peterson, 1977).

Nicholls (1978) suggests that causal reasoning occurs somewhat later. The results of his research suggested that an age of approximately 11 years may be required for the children to logically analyze the causes of success or failure.

The reality of Logo usage in the school appears to be a compromise between the estimates of child developmental theorists regarding causal reasoning. Between these two theorists, Bitter (1983) in his scope and sequence model of a full-school (K-12) computer curriculum, suggested that Logo programming beyond preliminary "turtling" be introduced in the third grade, and expanded in the fourth grade. According to a recent survey by Lough and McCurdy (1984-1985), children in these grades (eight - 10 years old) seem representative of a substantial portion (27.13%) of the K-12 Logo users in the United States.

Empowerment and Locus of Control

He seemed to want to confer as much as possible a sense of autonomous existence on the computer (which) gave him an overpowering sense of control. (Turkle, 1984, p. 132)

Empowerment as a desired attitudinal disposition in children's learning is well represented in the literature (Seeman, 1967; Simmons & Parsons, 1983). This review has indicated a general agreement among investigators that children's perceived power, or feelings of control with respect to their academic and social environment, is desirable and should be fostered. Internality on the locus

of control scale is frequently used as an equivalent for perceived personal power (Hill, 1978; Horner & Maddux, 1985; Louie, 1985a). The term powerlessness has been used as a synonym for externality (Minton, 1976; Seeman, 1959; Strickland, 1973a). Nowicki and Duke (1974) include the factor "Power versus Helplessness" as an equivalent internal-external measure in their LOC instrument, the Preschool-Primary Nowicki-Strickland Internal-External Control Scale. The empowerment of children as a direct result of their work with computers and the Logo computer language is a stated premise of Seymour Papert (1980) in his educational book Mindstorms: Children, Computers, and Powerful Ideas.

Papert (1980) refers to children actively learning to program as a source of power for them (p. 21). To these students, learning with Logo becomes a self-directed and personalized process. His stated "empowerment" of children as a benefit of learning programming with the computer language Logo is twofold: (1) the child will gain mastery over the computer (and thereby control over the computer), and (2) this mastery may generalize to the child's overall perceived sense of control, resulting in an "empowering" effect. This notion of "overall" control may be operationalized as the child's perceived locus of control

(Horner & Maddux, 1985; Louie, 1985b; Papert, 1971, 1980; Robyler, 1985).

Weir (in press) states that "most are agreed that the computer gives the child a degree of active control over the learning process that does not exist in the traditional student-teacher relationship." Hyperactive children, says Dr. Weir (personal communication, June 20, 1986) "perceive an external locus of control, meaning that events beyond their control happen to them." She blames the "emotional lability that they display with not being able to follow their own intentions, with the feeling they have of not being in control in a standard classroom." That children are absolutely in control, finding that they can actually make a difference to their environment, has a very powerful effect on their self-image and their sense of what they are. This perceived control, says Weir (1983), can make a very important difference to the amount of learning that can take place as well. Being in control means that you are actively thinking out solutions to problems, and this leads to real learning (Weir, 1983). Gray (1984) and Ryba and Chapman (1983) provide other examples of special education students achieving a greater sense of control over their computerized learning environments, leading to heightened self-worth and independence.

Turkle (1984) referred to computer users' programming activities as cognitive play that gave them a feeling of power and control. Crandall (1977; as cited in Ryba & Chapman, 1983) stated that computer interactions could be effective for building internal control in those students in whom it is lacking. These statements indicate that individuals' feelings of personal control and effectiveness with computers may generalize to their perceived control within their environment. They are, however, quantitatively unsubstantiated claims and suggest the need for research to determine their validity.

This study was an attempt to determine (1) what the effect of computer use and Logo programming instruction was on third and fourth grade students' perceived control of computers; (2) to what degree this effect (if any) generalized to the students' feeling of overall perceived control as reflected by a measure of the psychological construct locus of control; and (3) if a relationship existed between achievement in Logo and the students' perceived locus of control.

Specifically, it was hypothesized that:

1. computer use and instruction with the Logo programming language will contribute to the children's greater senses of perceived control over computers.

2. computer use and instruction with the Logo programming
   language will contribute to a greater sense of
   generalized perceived control by the children.
3. a relationship will be found between achievement in Logo
   and the children's perceived locus of control.

Method

The effect of computer use and Logo instruction on
third and fourth grade students' perceived control of
computers and perceived locus of control was determined
using a nonequivalent control group design. Treatment group
students received Logo instruction and unstructured
programming. Control group students received regular
science instruction in place of Logo instruction during the
intervention.

Participants

Ninety-three third- and fourth-grade students in four
intact classes from a public elementary school in a
southwest Virginia university town were chosen as
participants in the study. At the beginning of the school
year, the principal assigned the children to classes on a
matching basis. Equal numbers of higher and lower
performers were selected for each of the classrooms, using
math and language arts Science Research Associates (SRA)

test scores as the criteria. There was, therefore, no reason to assume great differences in the make-up of the classes. Permission for the children to participate in the study was requested from their parents through written communication (see Appendix A).

Three of the children (all from the control group) moved away before the completion of the treatment period, leaving 90 participants. Two treatment groups (n=45) in the study consisted of 23 third graders and 22 fourth graders. The two control groups also had 45 students, 22 in the third grade and 23 in the fourth grade.

Treatment and control group selection was based on administrative scheduling. All classes in the host school participated in Logo instruction at some time during the year. Logo instruction was scheduled for the first afternoon period of each school day. Third grade and fourth grade classes were selected from the pool of classes who had not yet received Logo instruction, and were assigned as treatment or control groups.

Materials

The basic instructional materials were: (1) 11 Apple II microcomputers, each with monitors (six color monitors, five with monochrome screens) and single disk drives, in separate computer stations; (2) Logo Computer Systems, Incorporated

(LCSI) Apple Logo software; and (3) two Microcomputer Resources' Logo Guided Discovery Kits. These kits provided the method and material base for both the third-grade and the fourth-grade treatment periods.

Instruments

Three instruments were used in the study: (1) the Children's Nowicki-Strickland Internal-External Locus of Control Scale (CNS-IE) was used to determine pre- and posttest measures of LOC orientation; (2) the Computer Control Survey (CCS) was used to provide more specific information related to students' attitudes toward and perceived control of computers; and (3) a posttest-only Logo quiz was administered to the treatment group to determine the group's Logo proficiency.

Children's Nowicki-Strickland Internal-External Locus of Control Scale

The CNS-IE instrument is a 40-item paper-and-pencil test for LOC orientation (See Appendix B). It is group administerable and has a forced-choice (Yes-No) response requirement. The instrument is scored externally, meaning that a higher score indicates greater externality. It has been used with students in all grades through high school.

A stated goal of the CNS-IE (Nowicki, 1976) is that gender and intelligence have no confounding effect on LOC scores. Nonsignificant correlations have been reported between IQ scores and CNS-IE results (Nowicki & Roundtree, 1971; Nowicki & Strickland, 1973). Mean CNS-IE scores of third and fourth grade males and females were essentially the same (Nowicki, 1976).

Moderate relationships exist between the CNS-IE and other LOC measures. Positively worded questions on the Intellectual Achievement Responsibility Questionnaire (IARQ) (Crandall, Katkovsky, & Crandall, 1965) and scores on the Bialer-Cromwell scale (Bialer, 1961) were found to be significantly correlated with CNS-IE scores of third-grade black ($\underline{n}$= 182) and third-, fourth-, and fifth-grade white ($\underline{n}$= 29) children (Nowicki, 1976).

Using the CNS-IE with third, fourth, and fifth grade children, Nowicki and Strickland (1973) report a six-week test-retest reliability of $\underline{r}$=.67, and a split-half internal consistency estimate of $\underline{r}$=.63 using the Spearman-Brown Prophecy Formula. Anderson (1976; as cited in Nowicki, 1976) reported a coefficient alpha of $\underline{r}$=.68 for third grade students ($\underline{n}$=80).

Gilmore (1978), in a review of comparable instruments, stated that, "The most attractive choice for measurement of

generalized LOC expectancies for administration and
continuity for different ages is the CNS-IE..." (p. 26).
Similarly, Kendall, Finch, Little, Chirico, and Ollendick
(1978) have stated that the CNS-IE is "the most reliable
measure of generalized locus of control appropriate for
children of a variety of ages" (p. 590) and MacDonald
(1973) described the CNS-IE as the "best available measure
of LOC for children" (p. 185).

Computer Control Survey

A group-administered survey was designed by the author
to assess students' attitudes toward Logo specifically and
computers generally, as well as their feelings of control
with respect to the computer (See Appendix C). Nine of the
items on the survey were designed to provide general
computer-related information about the sample. The control
questions on the Computer Control Survey (CCS) were modeled
after the CNS-IE, and structured in a computer-learning
context. The CCS is a 22-item instrument, comprised of 13
items which relate to various aspects of children's
perceived control with respect to computers and computer
use. These 13 items are scored externally, just as the CNS-
IE is scored. The 13 items were numbers 1, 4, 9, 10, 12,
13, 14, 15, 16, 18, 19, 20, and 21.

Logo Quiz

A 20-item Logo quiz was created to determine the treatment groups' Logo proficiency (see Appendix D). The items were formatively developed with the host school's elementary computer teacher and judged to adequately reflect the Logo course objectives, and contain questions at an appropriate cognitive level for third and fourth grade children.

Procedures

The two treatment groups each received a two-week (10-day), instructional unit, consisting of daily, 50-minute periods of Logo instruction. The two-week instructional unit for each of the grade levels was followed by 13 weeks of supervised project work. Minimum designated hands-on computer time for each student during this 13-week period was 30 minutes per week. The students maintained a weekly record of their computer time through a self-report measure, the Logo Log (an example of one such record is given in Appendix E). The instructional unit, together with the project work, resulted in a full 15-week treatment.

Instruction for the third grade treatment group was given on 10 consecutive school days (November 11, 1985 to November 22, 1985), followed by instruction for the fourth grade treatment group on the next 10 consecutive school days

(December 2, 1985 to December 13, 1985). The 13 weeks of supervised experimentation and project work with Logo ended on March 7, 1986, for the third graders. The fourth graders ended their 15-week treatment on March 28, 1986 (see Figure 1). During the entire treatment period, from November 11, 1985 until April 1, 1986, all third- and fourth-grade control group students received regular science instruction in place of computer instruction.

A one-hour class period on the first available school day following each of the two student groups' 15-week treatment was used for a capstone experience. This experience consisted of the children being given a review of Logo programming commands and strategies by the computer teacher. The third grade treatment group received the capstone experience on March 10, 1986, and the fourth grade treatment group received the capstone experience on April 1, 1986.

Instruction

A structured approach was used for the instruction which was based on curriculum materials presented in the Microcomputer Resources' Logo Guided Discovery Kits. The lessons consisted of teacher demonstration and provision of Logo programming commands and procedures. Individualized teacher guidance and hands-on programming experiences were

Weeks   1   2   3   4   5   6   7   8   9   10   11   12   13   14   15   16   17

begins Nov. 11
1985
third grade
instruction
(2 weeks)

Logo project work
(13 weeks)

March 7,
1986
end of
third grade
treatment

begins Dec. 2,
1985
fourth grade
instruction
(2 weeks)

Logo project work
(13 weeks)

March 21,
1986
end of
fourth grade
treatment
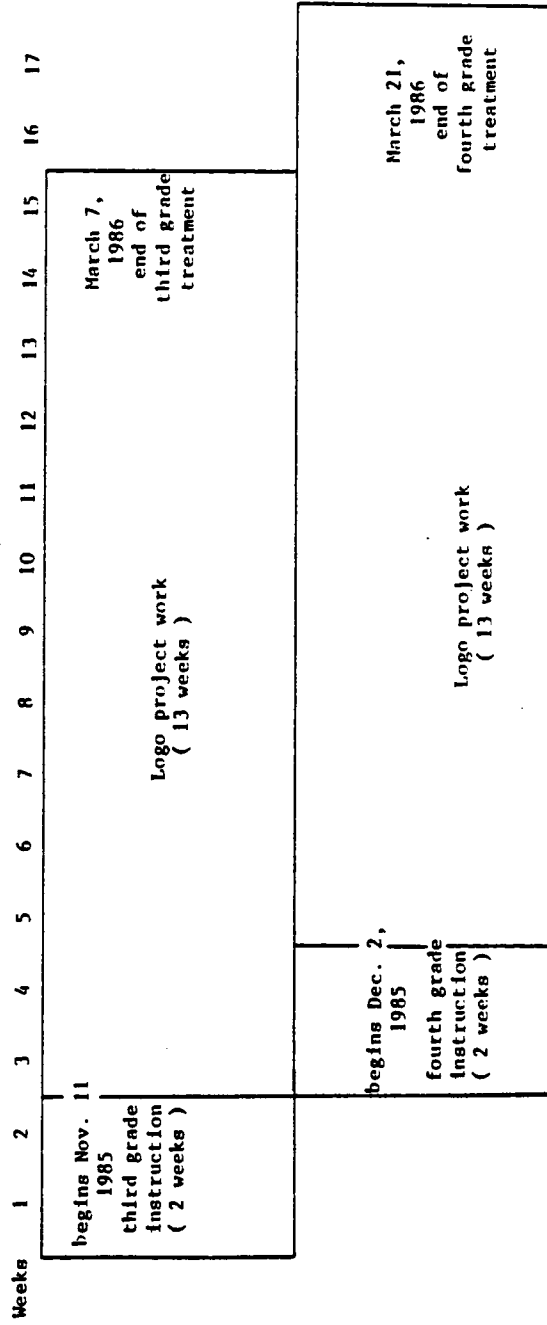
Figure 1. Time Frame for Third and Fourth Grade Treatment

built into the series of ten lessons. Each of the two treatment groups received the following sequence of lessons in Logo.

Lesson One introduced the essential Logo commands to the children. Commands such as ST (show turtle), HT (hide turtle), CS (clear screen), FD (forward), BK (back), RT 90 (right 90 degrees), LT 90 (left 90 degrees), and HOME (clear the screen and return the turtle to the center of the screen) allowed the children to begin "turtling" (Tipps, 1982, p. 8), or moving the turtle, and exploring the screen.

Lesson Two provided the children with targets on the screen. In hands-on exercises, the children developed skills in using Logo commands to control the turtle and hit the targets. Color commands were introduced to the children at this point.

Lesson Three challenged the students to use Logo commands to write programs that draw geometric objects on the screen. Squares, triangles, and polygons were created by the children.

Lesson Four introduced the REPEAT command, which provided the children with a valuable programming tool, allowing them to repeat an instruction for any number of times indicated. They were challenged by the computer teacher to write efficient programs to draw a variety of geometric shapes.

Lessons Five, Six, and Seven introduced the children to the Logo editor. The editor allowed the children to rewrite their programs and see the results (part of the debugging process) more quickly. Using this programming tool, the children were given time and assistance in creating their own programs. The students worked in pairs within an unstructured format. They were encouraged to program efficiently by having the teacher (1) demonstrate good programming techniques, and (2) suggest helpful ways of accomplishing their programming goals.

Lesson Eight was largely a review session in which the teacher modeled good Logo programming strategies. Programming exercises in problem-solving were given to the children to work on at the computer. An example of one of the problems was: write the shortest possible program to create a circle.

The final two sessions, Nine and Ten, provided the children with further information about computer hardware. In addition, time was allowed for open lab and individual work.

Teachers

The treatment groups received Logo instruction from the host school's appointed computer teacher. The teacher was recommended highly by the county computer coordinator and members of the county school administration.

The two treatment groups' classroom teachers assisted the computer teacher during each of the two-week instructional units. Because the teachers involved in the study had participated in a Logo workshop given by the county computer coordinator during the previous school year, it was assumed that they were competent to give instruction and guidance in Logo programming. In the workshop, the teachers received six hours of Logo instruction. This instruction consisted of (1) an introduction to the language, (2) guided hands-on Logo experiences, and (3) provision of sample programs that could be adapted for use across grade levels (Price, 1985).

The 13 weeks directly following each of the treatment group's two-week instructional units were supervised by the classroom teachers with occasional assistance from the computer teacher. During this time the children operated within an unstructured format. The classroom teachers monitored the students' record-keeping of time spent at the computer. The desired minimum computer time per student was set at 30 minutes. The classroom teachers provided time for the children to do Logo work during the week to ensure that this minimum time was met.

During the treatment period, parent volunteers supervised the computer lab several mornings each week

before school. This allowed some students extra computer time.

Administration of the instruments

A pretest-posttest control group design was used to measure changes in LOC and perceived control of computers of treatment and control groups in third and fourth grade elementary students. The instruments (CNS-IE, and CCS) were administered as pretests to all treatment and control groups prior to the treatment at both grade levels. Following the 15-week treatment period for each of the two grade levels, the instruments were again administered to all treatment and control groups. The two instruments were administered by graduate students in education, who were experienced in giving tests of this type, and who had been provided instructions in accordance with the Nowicki (1976) administration guide.

Both the CNS-IE and the CCS were given to the third grade treatment and control groups on the school day prior to the beginning of the instructional unit. After the full 15-week treatment, both instruments were again administered to the treatment and control groups. After the third grade treatment group received the 10-day instructional unit, all the fourth grade students were pretested. The fourth grade treatment group was given the 10-day instructional unit

immediately upon completion of the pretest. Fourth grade
treatment and control groups were posttested with both
instruments on the first school day after the full 15-week
treatment period.

The administrator of the instruments distributed the
tests to all treatment and control groups as intact groups.
First the CNS-IE was administered; this was followed after a
few minutes break by the CCS. All items on the two tests
were read aloud and repeated once by the administrator.
Each session began with the administrator distributing the
CNS-IE and providing these comments, "We are trying to find
out what boys and girls your age think about certain things.
We want you to answer the following questions the way you
feel. There are no right or wrong answers. Don't take too
much time answering one question, but do try to answer them
all" (Nowicki, 1976, p. 1). Each test was collected
immediately after it was administered.

Analyses of Data

Two three-way factorial ANCOVAs for the independent
variables of grade level (third and fourth), gender, and
treatment (experimental and control) were planned and
performed for the two dependent measures, the CCS and the
CNS-IE. Upon examination of the item intercorrelations for
the 40-item CNS-IE, a third ANCOVA was performed using
selected items.

Analysis of Covariance

The reasons for using the ANCOVA in these analyses were (a) its applicability to the desired analysis of these data, and (b) the fact that it was necessary to use intact groups. Huck, Cormier, and Bounds (1974) refer to the use of the ANCOVA as the preferred statistical procedure when using the pretest-posttest control group design. According to Kerlinger (1973), the use of intact groups and the ANCOVA is a poor alternative to random assignment or matched groups with analysis of variance; however, Campbell and Stanley (1963) recommend the use of this design with intact groups when randomization is impossible. The host school administration was understandably reluctant to break up classes for the study.

Analysis of covariance, with pretest scores used as the covariate, allows for the control of initial differences related to the subjects' posttest scores. The final measures, or the adjusted posttest means of the treatment and control groups for each of the dependent measures, were compared and analyzed for statistically significant differences.

Results

Children's Nowicki-Strickland Internal-External
Locus of Control Scale

A three-way analysis of covariance was used to analyze the entire 40-item CNS-IE instrument. This ANCOVA tested for differences between the means of the independent variables group, grade, and gender with each of the total CNS-IE posttest scores ($\bar{X}$=14.96, SD=4.04) as the dependent variables, and the pretest scores ($\bar{X}$=14.73, SD=4.00) as the covariate. Adjusted posttest scores among the groups proved not significantly different ($\underline{F}$(1,88)<1.0). A coefficient alpha was computed using the pretest scores of the CNS-IE. The computation yielded .60, was significantly different from zero ($\underline{p}$<.05) and was considered to be a useful measure for the study. Appendix F shows the results of this ANCOVA, and Table 1 lists the means of the CNS-IE pretests and posttests.

An historical precedent exists for examining segments of the CNS-IE instrument. Factor analyses of the CNS-IE have been done by Nowicki (1976) and Piotrowski and Dunham (1983). An item analysis was performed on the entire CNS-IE instrument. Using the Pearson product-moment correlation coefficient, each of the 40 CNS-IE items was correlated with the total pre- and posttest results. Only eight of the

Table 1a

Pre- and Posttest Means and Standard Deviations of the Children's
Nowicki-Strickland Locus of Control Scale by Grade

	Treatment					Control				
	N	Pretest		Posttest		N	Pretest		Posttest	
		$\bar{x}$	sd	$\bar{x}$	sd		$\bar{x}$	sd	$\bar{x}$	sd
3rd	23	14.07	3.07	15.74	3.65	22	14.41	5.15	14.68	5.02
4th	22	14.77	4.88	14.14	4.36	23	15.52	4.51	14.48	4.79
Total	45	14.73	4.00	14.96	4.04	45	15.47	4.78	14.58	4.85

Table 1b

Pre- and Posttest Means and Standard Deviations of the Children's
Nowicki-Strickland Locus of Control Scale by Gender

		Treatment						Control			
	N	Pretest		Posttest		N	Pretest		Posttest	
		$\bar{x}$	sd	$\bar{x}$	sd		$\bar{x}$	sd	$\bar{x}$	sd
Boys	23	14.70	3.07	15.09	3.55	27	14.52	4.55	13.70	4.76
Girls	22	14.77	4.88	14.82	4.58	18	16.89	4.89	15.89	4.80
Total	45	14.73	4.00	14.96	4.04	45	15.47	4.78	14.58	4.85

items on the instrument were found to correlate with the total score of the pre- and posttest results at a level deemed to be above chance (p<.05). These correlations for the eight items ranged from .24 to .52. The items showing these degrees of correlation were numbers 5, 7, 10, 14, 18, 29, 33, and 36. All eight of the items were reported in the above factor analyses as representing a single factor: Helplessness. Nowicki (1976) states that this factor includes items which measure a "general feeling of helplessness and failure to control or direct things occurring around the person" (p. 15).

Because of the established reliability of these items, a three-way analysis of covariance was used to test for differences between groups, grades, and gender of the sample, using the posttest results ($\bar{X}$=3.24, SD=1.72) of these eight items as the dependent variable. The pretest scores ($\bar{X}$=3.31, SD=1.87) were used as the covariate. Comparison of adjusted posttest scores of the reliable CNS-IE items on each of the groups indicated that there were no significant differences (F(1,88)=1.005, p>.05). A coefficient alpha was computed using the pretest scores of the eight CNS-IE items. The computation yielded .57. Appendix G indicates the results of this ANCOVA, and the pretest and posttest means are displayed in Table 2.

Table 2a

Pre- and Posttest Means and Standard Deviations of the Reliable Items of the Children's Nowicki-Strickland Locus of Control Scale by Grade

		Treatment						Control				
	N	Pretest		Posttest			N	Pretest		Posttest		
		$\bar{x}$	sd	$\bar{x}$	sd			$\bar{x}$	sd	$\bar{x}$	sd	
3rd	23	3.09	1.68	3.09	1.44		22	3.50	2.06	3.45	2.04	
4th	22	3.55	2.06	3.41	1.99		23	3.57	2.00	3.30	1.99	
Total	45	3.31	1.87	3.24	1.72		45	3.53	2.01	3.38	1.99	

Table 2b

Pre- and Posttest Means and Standard Deviations of the Reliable Items
of the Children's Nowicki-Strickland Locus of Control Scale by Gender

| | Treatment | | | | | Control | | | | |
| | N | Pretest | | Posttest | | N | Pretest | | Posttest | |
		$\bar{x}$	sd	$\bar{x}$	sd		$\bar{x}$	sd	$\bar{x}$	sd
Boys	23	3.26	1.42	3.17	1.37	27	3.26	1.85	2.81	1.69
Girls	22	3.36	2.28	3.32	2.06	18	3.94	2.21	4.22	2.16
Total	45	3.31	1.87	3.24	1.72	45	3.53	2.01	3.38	1.99

Computer Control Survey

Because this instrument was created specifically for the study, it was important to establish the reliability of the 13 items that were used for the purpose of determining the children's perceived control of the computer. Kerlinger (1973) states that unless a test is reliable, "one cannot, with any confidence, determine the relations between the variables" (p. 454-455). A coefficient alpha was computed using the students' posttest responses to the CCS. The computation yielded .54. This value is significantly different from zero (p<.05) and is considered sufficient for an experimental study of this type (R. Frary, personal communication, April 21, 1986).

Using the CCS, a third analysis of covariance was used to test for differences between groups, grades, and gender of the sample. The results of the CCS were scored in a similar fashion to the CNS-IE. That is, a lower score indicated greater internality. In each case, the posttest scores ($\bar{X}$=1.89, SD=2.10) on the CCS represented the dependent variable and the pretest scores ($\bar{X}$=2.13, SD=1.80) were used as the covariate. A comparison of the adjusted posttest scores of the ANCOVA between these independent variables indicated that no statistically significant differences existed between the groups (F(1,88)<1.0).

Appendix H shows the results of this ANCOVA, and the pretest and posttest means for the CCS are given in Table 3.

Logo Quiz

A 20-item post-treatment Logo quiz was administered to the treatment groups to measure the children's degree of Logo proficiency. The instrument may be found in Appendix D. A high degree of understanding and proficiency in Logo was indicated by the students' scores on the quiz ($\bar{X}$=18.76, SD=1.43, Range=15-20). A coefficient alpha was computed using the Logo quiz results. The computation yielded .55, and the quiz was deemed adequate (p<.05) for use in this experiment.

To answer the third research question, the achievement scores of the Logo quiz were correlated with (1) the children's perceived control of computers, as measured by the CCS, and (2) the children's perceived LOC, as measured by the reliable items of the CNS-IE. Using the Pearson product-moment correlation coefficient, a significant linear association was found to exist between the students' achievement on the Logo quiz and their perceived control of the computer, as measured by the CCS (r=-.51; p<.05). This means that the children who performed better on the Logo achievement quiz also felt more confident and in control of their computerized environment. In addition, the results of

Table 3a

Pre- and Posttest Means and Standard Deviations of the
Computer Control Survey by Grade

		Treatment						Control			
	N	Pretest		Posttest		N	Pretest		Posttest		
		$\bar{x}$	sd	$\bar{x}$	sd		$\bar{x}$	sd	$\bar{x}$	sd	
3rd	23	2.43	1.56	1.87	1.74	22	2.36	1.84	1.95	1.53	
4th	22	1.82	2.02	1.91	2.47	23	2.70	2.29	2.13	1.36	
Total	45	2.13	1.80	1.89	2.10	45	2.53	2.06	2.04	1.43	

Table 3b

Pre- and Posttest Means and Standard Deviations of the
Computer Control Survey by Gender

| | Treatment | | | | | Control | | | | |
| | N | Pretest | | Posttest | | N | Pretest | | Posttest | |
		$\bar{x}$	sd	$\bar{x}$	sd		$\bar{x}$	sd	$\bar{x}$	sd
Boys	23	1.65	1.30	1.70	2.34	27	2.44	2.17	2.07	1.49
Girls	22	2.64	2.13	2.09	1.85	18	2.67	1.94	2.00	1.37
Total	45	2.13	1.80	1.89	2.10	45	2.53	2.06	2.04	1.43

the higher performers on the Logo achievement quiz showed a linear association with posttest scores on the reliable items of the CNS-IE (r=-.34; p<.05). This means that children in the study who demonstrated better knowledge of Logo were also more internal. Determination of the Pearson product-moment correlation coefficient between Logo achievement scores and the full 40-item CNS-IE scores yielded nonsignificant results (r=-.21; p>.05).

Logo Log

The Logo log was a self-report measure, which was designed to allow the experimental group children to maintain a running account of their computer time during the 13-week project-oriented phase of their treatment. An example of the instrument may be found in Appendix E. The children filled in squares on the log (each square representing 5-minute increments of computer time) after each session with the computer. Determination of the overall mean time per week that both experimental group individuals spent on Logo yielded 32.8 minutes. The third grade students averaged 35.8 minutes of Logo per week, and the fourth grade children averaged 29.8 minutes of Logo per week. This satisfied the 30-minute-per-week target computer time desired for each child.

Conclusions

Much has been said about the relationship between greater school achievement and higher internality (Bar-Tal & Bar-Zohar, 1977; Coleman et al. , 1966; McGhee & Crandall, 1968; Nowicki & Strickland, 1973). In fact, one reason for the popularity of the LOC construct in educational research is because of its relationship to higher academic achievement and more positive personal and social behaviors. Certain positive correlations were found in the study. A significant correlation was found in the sample between achievement on the Logo quiz and perceived control of the computer, as measured by the posttest scores of the CCS. That is, children who performed better on the Logo achievement test also felt more confident and in control of their computer environment. Also, the higher performers on the Logo achievement test showed a linear association with posttest scores on the reliable items of the CNS-IE. The children who demonstrated better knowledge of Logo, it appears, were also more internal. What one cannot determine from these data is any causal direction regarding treatment or effect. The higher Logo achievement scores could have been due to greater internality. Since the study did not demonstrate significant statistical differences in the Logo users versus the control group, the case for the

hypothesized computer treatment leading to empowerment of the children, and then generalizing to a greater perceived control of their environment cannot be substantiated. What may be said is that a relationship existed between the children's knowledge of Logo and their feelings of control regarding their computerized as well as generalized environments.

This linear association between Logo achievement and internal LOC on the eight-item instrument did not extend to the full 40-item CNS-IE correlation with Logo achievement. Since only eight of the 40 CNS-IE items were deemed reliable, this finding could have been expected.

The results of this study did not support the claims of Papert (1971, 1980) and others (Louie, 1985a, 1985b; Noss & Tagg, 1985; Ryba & Chapman, 1983) that children who are provided with an opportunity for programming in Logo may perceive themselves as being "empowered" as a result. The dependent variables that measured the children's empowerment (which was operationalized as perceived control) were (1) the Children's Nowicki-Strickland Internal-External Control Survey (CNS-IE), (2) selected reliable items from the CNS-IE, and (3) the Computer Control Survey (CCS). No differences in the dependent variables were found between the group that programmed in Logo and the control group

which, according to teacher reports, had no contact with computers or Logo during the treatment period. Possible reasons for the lack of significant differences in the obtained posttest scores of the dependent variables will be considered.

Internality of the Sample

The student sample (N=90) was found to have a pretest 40-item CNS-IE mean score of 15.07. This initial value is considerably more internal than the third grade (male: $\bar{x}$=17.97; female: $\bar{x}$=17.38) and fourth grade (male: $\bar{x}$=18.44; female: $\bar{x}$=18.80) students tested by Nowicki & Strickland (1973). In addition, Nowicki & Walker (1973) found that third grade male students in their sample had a mean score of 18.67 (n=40) on the CNS-IE, with females (n=38) scoring a mean of 18.04. Strickland (1972), working with third graders (N=30), found the average CNS-IE score of their sample to be 17.63. Tyler and Holsinger (1975; as cited in Nowicki, 1976) reported the male (n=35) fourth graders' mean score to be 17.03; females (n=35) in this study were found to have a mean score of 16.6 on the CNS-IE.

The CNS-IE pretest means of third and fourth grade children, as reported by the above researchers, are two to three and one-half points (nearly one standard deviation) above the pretest means of the present study. It appears,

therefore, that the study sample exhibits a particularly
high internal orientation when compared to other populations
of the same age. Because of the prior high level of
internality of the students who worked with Logo, it would
seem that the probability of the treatment group achieving
any dependent variable movement toward even greater
internality may have been diminished.

Prior Computer Experiences of the Sample

Previous computer work and some prior Logo experience
were noted among the sample and could have contributed to
the lack of significant differences found between treatment
and control groups. All but two students in the study
reported having had some experience with a computer.
Twenty-nine (32%) of the children in the study (treatment
group=17; control group=12) indicated that they had a
computer at home. Fifty-nine (65%) of the children
(treatment group=30; control group=29) reported having used
Logo before. Discussions with the teachers revealed that
this high incidence of reported prior Logo use may have been
due to the school-wide use of "Turtle Tracks," a simplified,
single-keystroke, Logo-like package.

In addition to the "Turtle Tracks" experience, it was
learned that several of the students had previously worked
with Logo as part of a university-school project in 1983.

In that study, the children had received a full exposure to the language, including hands-on experiences, in four hour-long sessions. High treatment group results on the Logo achievement quiz indicated a good knowledge of Logo. Low (meaning high internal) pretest means for the 13-item CCS results (treatment $\bar{X}$=2.13; control $\bar{X}$=2.53) would seem to substantiate the expected feelings of control over the computer that children with these prior experiences should have.

The above findings are representative of the current difficulty that researchers have in obtaining samples that are not confounded to some degree by subjects' prior computer experience (Louie, 1985a). The amount and quality of the children's prior computer experience may have contributed to the lack of significant findings in this study. Treatment effects may, therefore, have already been in evidence before the pretest was given and affected the posttest results.

Length of Treatment

Another factor that could have contributed to the lack of significant differences in the two groups was the short length of the treatment. In spite of the recognized potential problems in obtaining measureable results in the short 15-week intervention period, it was determined that

this was a realistic, even expected, offering of computer education in this elementary school. The host school had a part-time computer teacher, thereby assuring each child some amount of computer instruction during the school year. Elementary school children in a school without an assigned computer teacher to plan instruction may expect to receive even less instruction than the sample.

The 15-week length of treatment may represent the average to above average computer access time that may be expected for many children in U.S. elementary schools. The Johns Hopkins survey of 1,600 schools (Becker, 1983a) found that a third of the elementary school users actually use the computer for 15 minutes or less per week. Of the remaining two-thirds of the students in this survey who received more than 15 minutes of computer access, most received only an additional 10 or 15 minutes per week. Becker (1983a) found that when more computers were purchased by the elementary schools, the opportunity for similar amounts of time on the computers were merely extended to a larger number of students.

Researchers that work with Logo have reported that some of the effects of Logo are not immediate, but may be expected and are worth waiting for (Tipps, 1982, 1984). Tipps and Bull (1985) point out that to avoid disappointment

in not achieving improved Logo learning effects, and
presumably enhanced affective measures, a "long-range view
is essential" (p. 281). Although Bank Street Logo research
(Pea, 1983) indicated that entry level Logo programming did
not present conceptual problems for eight to 12-year-old
children (which is consistent with observations of this
sample) greater programming expertise leading to affective
gains in these children may require more time. Clements
(1985) states that insufficient time to understand the
sophisticated concepts of Logo was alloted the children who
worked in this and other Bank Street studies. Kurland,
Mawbry and Cahir (1984) indicate that ". . . many students
fail to achieve even a modest understanding after one or two
programming courses" (p. 2). In a study of six schools,
Linn and Dalbey (1985) found that a "majority of students
made very limited progress in programming" (p. 202).
Similarly, the Logo treatment group in the present study may
not have had sufficient time to gain the expertise leading
them to experience the sense of mastery and control of which
Papert (1971, 1980) speaks.

Age of the Sample

The age of the children in a Logo computer study is an
important consideration (Clements & Nastasi, 1985). It is
possible that the children in the sample used in this study

were too young to be able to differentiate between the causal factors of effort, ability, and chance. Although the children were thought to be, generally speaking, within the Piagetian stage at which concrete operations are understood, perhaps they were cognitively unable to operate with the full power of the Logo language. This could have reduced the children's resultant affective gains.

Nicholls (1979) has indicated that attributional schemes of most children are not fully developed until age 11 or older. Since the treatment children were from eight to 10 years old, with a mean age of about nine, perhaps many of them could not differentiate between the causal factors of effort, ability, and chance. Stipek and Tannatt (1984) note that young children may attribute success on a very simple task to ability alone. Development of computer expertise requires a level of maturity (Burton & Magliaro, 1986). Children still within the concrete operations stage of cognitive development may not be capable of experiencing some of the power that the Logo language purportedly offers. Because of this, they may not have been able to experience the resultant affective gains which this study sought to measure.

In summary, the treatment did not produce the hypothesized differences in the posttest dependent

variables. As indicated, the internality, prior computer experience, length of treatment, and age of the sample may have contributed to this lack of hypothesized treatment effect on the children, and, from a design standpoint, the necessity of intact groups could have created bias in either the treatment or control groups. Of course, the simplest and most obvious explanation for the failure to detect differences between the groups is that there were none; that Logo instruction leading to Logo programming experiences do not produce significant differences in perceived mastery of the computer, nor generalized differences in LOC.

Recommendations

Future research conducted in this area should control, in some way, for the prior computer experiences of the children. A non-university setting is therefore advised for further research of this nature. It is difficult to find a representative sample in a university town, regarding internality, prior computer experience, and general attitude toward classroom innovation.

It is also recommended that future studies of this nature provide more cross-school, cross-grade representation in the sample. Researchers could more adequately measure the age relationships by including more lower and upper elementary grades in these studies. Similarly, individual

differences in SES across several schools have been considered with a broader range of samples.

Perhaps attention should be given to the CNS-IE measure of LOC. A review of the instrument may be in order as only eight of the 40-items were found to be reliable. Furthermore, all of these items appeared to measure a single factor: Helplessness.

It is recommended that future studies control for instructional method. Mastery of programming skills can vary greatly with the method of instruction. Larger studies would necessarily involve more teachers, and presumably variations in methods of teaching. How Logo is taught to the children (e.g., structured vs. unstructured) may have important effects on their mastery of the language (Kinzer, Littlefield, Delclos, and Bransford, 1985).

In addition, a longer treatment period is definitely recommended in future Logo studies attempting to measure affective gains. The children need to feel that they know Logo sufficiently enough to become experimental and creative with the language. More programming time, with presumably greater competence and more successes, leading to a greater diversity of Logo experiences, should allow the children to individualize their programming style and more closely identify with it. Individualizing Logo may serve to make

Logo their own, as Papert (1983) says, and perhaps lead to a greater potential for exhibiting the sense of mastery and personal power of which he speaks.

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APPENDICES

APPENDIX A

LETTER TO PARENTS AND PERMISSION SLIP

VIRGINIA POLYTECHNIC INSTITUTE AND STATE UNIVERSITY

Blacksburg, Virginia 24061 - 8498

DIVISION OF CURRICULUM AND INSTRUCTION

November, 1985

Dear Parent,

As part of an ongoing investigation with Margaret Beeks students and their use of the computer language Logo, we wish to include your child in a research project. The focus of the study will be on the impacts of computer use and computer programming instruction on the children's perceptions of themselves and their abilities relative to the computer.

To help with this research, we ask the children to complete paper and pencil tasks before and after their regularly scheduled computer instruction. We hope to measure perceived control and achievement gains resulting from the instruction. All test results will be kept confidential and coded by number rather than name. The tests will involve no deception or hidden purposes.

This research constitutes an attempt to provide some sound information concerning the effects of computers in education. It will be conducted under the guidance of the Virginia Tech Education Microcomputer Lab and Montgomery County Schools. We ask that you sign the enclosed permission forms.

Sincerely,

Donovan Cook
Virginia Tech

Enclosure

I, _____ the undersigned

and parent or guardian of _____,

having been advised of the nature of, and purposes for the

computer programming research project, do hereby consent to

having my child tested in accordance with the procedures

described. I understand that I have the right to withdraw

this permission at any time during the project. I further

understand that I have the right to review the instruments

and to have the results of the study explained to me.

_____   _____
          (Signature)   (Date)

APPENDIX B

CNS-IE

Appendix B

THE NOWICKI-STRICKLAND PERSONAL REACTION SURVEY

Circle your choice

| | YES | NO | 1. | Do you believe that most problems will solve themselves if you just don't fool with them? |

YES NO   1. Do you believe that most problems will
               solve themselves if you just don't
               fool with them?

YES NO   2. Do you believe that you can stop
               yourself from catching a cold?

YES NO   3. Are some kids just born lucky?

YES NO   4. Most of the time do you feel that getting
               good grades means a great deal to you?

* YES NO 5. Are you often blamed for things that
               just aren't your fault?

YES NO   6. Do you believe that if somebody studies
               hard enough, he or she can pass any subject?

* YES NO 7. Do you feel that most of the time it
               doesn't pay to try hard because things
               never turn out right anyway?

YES NO   8. Do you feel that if things start out well
               in the morning, that it's going to be
               a good day no matter what you do?

YES NO   9. Do you feel that most of the time parents
               listen to what their children have to say?

* YES NO 10. Do you believe that wishing can
               make good things happen?

YES NO   11. When you get punished, does it usually
               seem it's for no good reason at all?

YES NO   12. Most of the time do you find it hard
               to change a friend's opinion?

YES NO   13. Do you think that cheering, more
               than luck, helps a team to win?

* YES NO 14. Do you feel that it's nearly impossible
               to change your parent's mind about anything?

YES NO 15. Do you believe that your parents should
            allow you to make most of your own decisions?

YES NO 16. Do you feel that when you do something
            wrong, there's very little that you can do
            to make it right?

YES NO 17. Do you believe that most kids are just
            born good at sports?

* YES NO 18. Are most of the other kids your age
            stronger than you are?

YES NO 19. Do you feel that one of the best ways
            to handle most problems is just to not
            think about them?

YES NO 20. Do you feel that you have a lot of choice
            in deciding who your friends are?

YES NO 21. If you find a four leaf clover, do you
            believe that it might bring you good luck?

YES NO 22. Do you often feel that whether you do
            your homework has much to do with what
            kind of grades you get?

YES NO 23. Do you feel that when a kid your age
            decides to hit you, there's little you
            can do to stop him or her?

YES NO 24. Have you ever had a good luck charm?

YES NO 25. Do you believe that whether or not
            people like you depends on how you act?

YES NO 26. Will your parents usually help if you
            ask them to?

YES NO 27. Have you felt that when people were mean
            to you, it was usually for no reason at all?

YES NO 28. Most of the time, do you feel that you
            can change what might happen tomorrow by
            what you do today?

* YES NO 29. Do you believe that when bad things are
            going to happen, they just are going to
            happen, no matter what you do to try
            to stop them?

YES NO 30. Do you think that kids can get their own way if they just keep trying?

YES NO 31. Most of the time do you find it useless to try to get your own way at home?

YES NO 32. Do you feel that when good things happen, they happen because of hard work?

* YES NO 33. Do you feel that when somebody your age wants to be your enemy, there's little you can do to change matters?

YES NO 34. Do you feel that it's easy to get friends to do what you want them to?

YES NO 35. Do you usually feel that you have little to say about what you get to eat at home?

* YES NO 36. Do you feel that when someone doesn't like you, there's little you can do about it?

YES NO 37. Do you usually feel that it's almost useless to try in school because most other children are just plain smarter than you are?

YES NO 38. Are you the kind of person who believes that planning ahead makes things turn out better?

YES NO 39. Most of the time, do you feel that you have little to say about what your family decides to do?

YES NO 40. Do you think it's better to be smart than to be lucky?

* Items which showed higher correlations with total scores on the CNS-IE.

APPENDIX C

CCS

Appendix C

COMPUTER CONTROL SURVEY

Circle your answer: YES or NO

* YES NO 1. When I use the computer, it does pretty much what I tell it to do.

YES NO 2. Boys are better than girls on computers.

YES NO 3. If I am going to have a bad day working on the computer, there's nothing that I can do to change it.

* YES NO 4. I feel that most of the time I can make the computer do what I want it to do.

YES NO 5. I like to use the computer.

YES NO 6. I like to teach the computer.

YES NO 7. I would rather have the computer teach me.

YES NO 8. I like to work on the computer with a friend.

* YES NO 9. Some kids are just born good at using the computer.

* YES NO 10. It is useless to try to do your best on the computer, because the "brains" in the class will make all the neat programs anyway.

YES NO 11. Computers are just machines that I can use in different ways to help me.

* YES NO 12. I don't feel that working hard on the computer is really worth it because I can't. make it do what I want it to do.

* YES NO 13. If I get a bug (make a mistake) in my computer work, there is very little that I can do to correct it.

* YES NO 14. When I sit down to work on the computer, I feel that I am the one who is in charge.

* YES NO 15. The best way to take care of problems that I am having on the computer is to just not

think about them.

* YES NO 16. The computer seems so difficult to use, that I often feel helpless when I try.

  YES NO 17. I like to work on the computer alone.

* YES NO 18. I feel in control when I use the computer.

* YES NO 19. When I plan out ahead of time just what I will do on the computer, I am able to make it do neat things.

* YES NO 20. I would rather hear the teacher tell about things than learn about things on the computer.

* YES NO 21. I am not able to use the computer as well as most of the other kids.

  YES NO 22. I have used Logo on the computer before.

  YES NO 23. I have a computer at home.

24. I spend ------------hours a day on a computer at home.

25. I spend -----------hours a week on a computer at school.

* Items which deal with various aspects of children's perceived control with respect to computers and computer use.

APPENDIX D

LOGO QUIZ

Appendix D

LOGO QUIZ

Please circle the correct answer:

1. What command will make the turtle appear on the screen?

    a) LD
    b) AP
    c) ST

2. What command will clear the screen?

    a) CS
    b) CN ·
    c) CL

3. What command would you give if you wanted to hide the turtle?

    a) HO
    b) ER
    c) HT

4. Which command will make the turtle go forward 50 steps?

    a) NE 50
    b) FD 50
    c) AH 50

5. What command will make the turtle turn right?

    a) RT 50
    b) AH 50
    c) ON 50

6. What command will make the turtle turn left?

    a) BK 50
    b) LE 50
    c) LT 50

7. What command will make the turtle go back?

    a) BK 50
    b) TX 50
    c) RT 50

8. What command will make the turtle return to its starting

point?

a) BACK
b) LOGO
c) HOME

9. What command will cause the turtle to stop making lines as it moves?

a) PD
b) PO
c) PU

10. What command will cause the turtle to make lines as it moves?

a) PD
b) PO
c) PU

11. What command would you give if you wanted to get out of the editor?

a) CTRL A
b) CTRL B
c) CTRL C

12. If you wanted to edit the procedure named BOX, how would you type it in?

a) EDIT "BOX"
b) EDIT "BOX
c) EDIT (BOX)

13. What would this procedure make if you typed it in?

FD 50
RT 90   a) circle
FD 50   b) square
RT 90   c) flower
FD 50
RT 90
FD 50
RT 90

14. What would this procedure make if you typed it in?

REPEAT 360 FD 1 RT 1   a) flower
                        b) square
                        c) circle

15. What would this procedure make if you typed it in?

```
FD 50
RT 90          a) rectangle
FD 100         b) triangle
RT 90          c) square
FD 50
RT 90
FD 100
RT 90
```

16. What should a Logo procedure end with?

a) QUIT
b) STOP
c) END

17. Which command would you use to stop the turtle during a procedure?

a) CTRL G
b) CTRL S
c) CTRL T

18. If you press CTRL D while you are in the editor, you will:

a) skip a line.
b) take away a letter.
c) take away the whole procedure.

19. If you press CTRL P while you are in the editor, you will:

a) skip to the next line.
b) skip to the previous line.
c) leave the editor.

20. If you press CTRL F while you are in the editor, you will:

a) move the cursor to the beginning of the procedure.
b) move the cursor back one line.
c) move the cursor forward.

APPENDIX E

LOGO LOG

85

MY LOGO LOG:

NAME_____ GRADE_____

each square = 5 minutes

Week 1.
Nov. 25

Week 2.
Dec. 2

Week 3.
Dec. 9

Week 4.
Dec. 16

Week 5.
Jan. 6

Week 6.
Jan. 13

Week 7.
Jan. 20

Week 8.
Jan. 27

Week 9.
Feb. 3

Week 10.
Feb. 10

Week 11.
Feb. 17

Week 12.
Feb. 24

Week 13.
Mar. 3

APPENDIX F

ANALYSIS OF COVARIANCE FOR THE CNS-IE

Appendix F

Three-way Analysis of Covariance: The Reliable Items of the Children's Nowicki-Strickland Locus of Control Scale

Source	df	MS	F
Groups (A)	1	.084	.037
Gender (B)	1	6.722	2.976
Grade (C)	1	.272	.120
AxB	1	5.205	2.304
AxC	1	.716	.317
BxC	1	1.041	.461
AxBxC	1	1.234	.546
Error	81	2.259	
Total	88		

APPENDIX G

ANALYSIS OF COVARIANCE FOR THE RELIABLE

ITEMS OF THE CNS-IE

Appendix G

Three-way Analysis of Covariance: The Children's

Nowicki-Strickland Locus of Control Scale

Source	df	MS	F
Groups (A)	1	12.822	.949
Gender (B)	1	2.124	.157
Grade (C)	1	21.763	1.612
AxB	1	5.145	.381
AxC	1	8.408	.622
BxC	1	3.193	.236
AxBxC	1	10.267	.760
Error	81	13.505	
Total	88		

APPENDIX H

ANALYSIS OF COVARIANCE FOR THE COMPUTER

CONTROL SURVEY

Appendix H

Three-way Analysis of Covariance: Computer Control Survey

Source	df	MS	F
Groups (A)	1	.000	.000
Gender (B)	1	.111	.040
Grade (C)	1	.613	.220
AxB	1	.087	.031
AxC	1	.515	.185
BxC	1	8.033	2.885
AxBxC	1	7.116	2.555
Error	81	7.419	
Total	88		