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ABSTRACT

This study considers the effects of Jostens Learning Corporation's Integrated Learning System (ILS) on the mathematics and reading standardized test scores of elementary school children. It was anticipated that test scores would increase modestly with the introduction of the ILS, particularly in mathematics. The sample consisted of four consecutive intact classes (N=85) taught by the same third-grade teacher. The first and second classes received traditional classroom instruction while the third and fourth classes received traditional classroom instruction plus standard sequence ILS instruction. The California Test of Basic Skills Total Mathematics and Total Reading scores given at the end of the third grade served as the posttest. The data were analyzed by mixed multi-variate analysis of covariance. A significant main effect for ILS treatment, and a significant interaction between content and treatment were observed. Under ILS, larger gains occurred for mathematics than for reading. Possible reasons for this finding are presented and the implications of the findings are discussed along with suggestions for further research. Contains 15 references. (Author)

The Effects of an Integrated Learning System on Third Graders' Mathematics and Reading Achievement

by
Roy B. Clariana

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This study considers the effects of Jostens Learning Corporation's Integrated Learning System (ILS) on the mathematics and reading standardized test scores of elementary school children. It was anticipated that test scores would increase modestly with the introduction of the ILS, particularly in mathematics. The sample consisted of four consecutive intact classes (final sample n = 85) taught by the same third-grade teacher. The first and second classes received traditional classroom instruction (baseline, control group) while the third and fourth classes received traditional classroom instruction plus standard sequence ILS instruction (treatment group). The California Test of Basic Skills Total Mathematics and Total Reading scores given at the end of the third grade served as posttest. The data were analyzed by mixed multi-variate analysis of covariance (MANCOVA). A significant main effect for ILS treatment, and a significant interaction between content and treatment were observed. Under ILS, larger gains occurred for mathematics, *es* = 0.49 than for reading, *es* = 0.06 (unadjusted). Possible reasons for this finding are presented and the implications of the findings are discussed with suggestions for further research.

Integrated learning systems (ILSs) are used by millions of school children each year. A survey conducted by Market Data Retrieval (1991) indicated that ILSs are installed in about 11% of K-12 school districts. Currently, ILS software purchases account for more than half of all educational software dollars (Bailey, 1993; Trotter, 1990).

Mary-Alice White (1993) describes several strengths of ILSs. She notes that ILSs provide mastery-learning based individualized interactive exposure to a systematic curriculum (usually mathematics, reading, and language arts) with comprehensive reports of student progress. Also, the "real" curriculum is available for critique, review, and revision.

Problematically however, a *useful* research base related to ILSs is practically nonexistent (Trotter, 1990). In a review of 30 studies of the effectiveness of ILSs, Becker (1992) noted that most were of an unsatisfactory quality (mostly methodological problems) and that no definitive conclusions could be obtained. Because of the extensive use of ILSs in American education despite the limited research base, additional ILS research and model building are critically important.

Is an ILS equally effective for both mathematics and reading? With an ILS, much thought has been applied to create a developmentally appropriate sequence of activities. This may be especially important in a hierarchically arranged content area like mathematics. Further, many mathematics concepts tend to be visual, and so may be easier to represent on a microcomputer (a visual medium) than concepts from reading comprehension or language arts. This does not mean that CBI is ineffectual in reading, only that CBI may be even more effectual with content areas like mathematics

For example, one study utilized mathematics and language arts ILS lessons along with teacher-directed lessons in a six-weeks summer remedial program for eighth-grade students. Pretest to posttest effect sizes of 0.44 for language arts and 0.76 for mathematics were observed (Clariana & Schultz, 1993). Becker (1993) reported about equal gains for reading and mathematics though mathematics was slightly greater. Given that other variables are about equal (e.g., time-on-task, support, ...), it seems reasonable that ILS gains in mathematics may be greater than gains in reading. At any rate, further research into this possible CBI differential effect by content is warranted.

Since the teacher is vitally important to student progress and achievement via CBI (Clariana, 1990), it is important to control for teacher effects. Therefore, this study considered the effects of an ILS on the standardized test scores of third-grade students taught by the same third-grade teacher.

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This study addressed the following questions: (a) is there a difference for mathematics versus reading scores, and (b) what sorts of effect sizes are observed on this standardized test.

Method

Participants

An initial sample of 115 third-grade students from a predominantly white, rural elementary school participated in the study. The initial sample consisted of four separate third grade classes taught by one teacher during a period of four consecutive years. Since district test policies provided for standardized testing at the end of both second and third-grades, these scores could be used to assess learning gains for the ILS implemented in the third grade. The final sample consisted of 85 of the original 115 students. Subjects were lost from the initial sample for various reasons such as incomplete test scores and lack of parental permission.

Program

Because of the powerful effects of an individual teacher on student achievement, the present study considered the effects of an ILS with one teacher. Two intact classes just prior to the ILS introduction were utilized as the baseline or control group, and two classes participating in the ILS served as the experimental group. Because of this lack of random assignment, pre treatment group equivalence was investigated by analysis of variance of standardized test scores (i.e., the California Test of Basic Skills) obtained during second grade. For reading, the control group (x = 68.2) was not significantly different than the ILS treatment group (x = 64.8), $F(1,84) = 0.43$. For mathematics, the control group (x=68.3) again was not significantly different than the ILS treatment group (x = 64.4), $F(1,84) = 0.57$. Note that this amounts to a pre-treatment effect size difference of $es \approx 0.2$ in favor of the control group.

The third-grade teacher in this study had more than 15 years of teaching experience in the district, most at the third-grade level. Also, this teacher used the same methods in the classroom with each class. During computer time, the teacher accompanied the students to the computer lab but was minimally engaged in instruction in the lab.

The ILS instruction consisted of Jostens Learning Corporation's (JLC) reading and mathematics expansions lessons for third grade. The software used was well designed, addressing text factors suggested by previous research like high proportions of highlights, cues, and prompts; wider margins; double-spacing; and multiple levels of help screens (Allesi & Trollip, 1985; Bork, 1987; Grabinger, 1983) as well as functional page formatting, item specific feedback, animation, extensive use of instructional graphics, and digitized audio (human-voice). Most importantly, the software automatically employed mastery-learning procedures with every activity, including additional remedial activities and sometimes direct teacher intervention (e.g., one-to-one tutoring) as necessary.

The mathematics software consisted of 957 activities that provided approximately 271 hours of instruction from kindergarten through fourth grade levels. The activity developmental sequence corresponded to the major mathematics textbooks in terms of content and sequence. Activities typically required 5 to 15 minutes to complete and were grouped together into lessons (e.g., numeration, whole number addition). A typical lesson began with one or two concept development activities that introduced the concept, typically in visual form. For example, age-appropriate animated graphic figures were used to demonstrate addition, number blocks and ten-sticks were manipulated to demonstrate place value, and matrices were shown to display multiplication concepts. Next, the student was provided directed practice containing high levels of prompts and cues, then automaticity practice followed, usually as a timed game activity. The lesson finished with an application activity (e.g., word problems, graphing, puzzle) that employed the concepts just learned.

The reading software consisted of 1080 activities that provided approximately 216 hours of instruction from kindergarten through third grade levels. The curriculum utilized a natural approach that emphasized understanding rather than memorization. For example, sounds were presented in contexts of words, and words were presented in the contexts of sentences. Skills were directly taught (e.g., visual discrimination, letter recognition, consonants, vowels, phonograms, decoding rules, sight words, vocabulary, and comprehension) but not in isolation. Nearly all words and sentences included on screen graphics of the word or sentence.

The students attended computer lab for 30 minutes daily through the regular school year. Equal amounts of time were scheduled each week for each subject area. The teacher was present in the lab but was only minimally involved. The ILS software placed the students into different portions of each curriculum (Clariana, 1991) and the students progressed through the standard ILS sequence at their own pace (Bond & Clariana, 1989).

Posttests

California Test of Basic Skills (CTBS/4) Mathematics Total and Reading Total scores served as posttest. Normal curve equivalent scores (NCE, an interval measure) rather than percentiles (NPR, an ordinal measure) were used for analysis. The test battery was given under regular classroom test conditions in the spring.

Results

The design was a mixed multi-variate analysis of covariance (MANCOVA), featuring one between-subjects factor (treatment: ILS versus control) and one within-subjects factor (content: reading and mathematics), two independent variables (third grade reading and mathematics scores), and two covariates (second grade reading and mathematics scores). Means and standard deviations are provided in Table 1.

TABLE 1. Observed means (as NCEs) and Standard Deviations for Third Grade CTBS Reading and Mathematics tests.

GROUP		READING	MATH
Control (n = 38)	Mean	63.6	50.6
	SD	26.0	23.9
ILS (n = 47)	Mean	65.3	62.4
	SD	25.0	24.9

The treatment effect was significant, $F(1,81) = 12.19$, $p = 0.001$ (see Table 2). The effect of the within-subjects variable was not significant. An ordinal interaction between the ILS treatment and content was found, $F(1,81) = 5.21$, $p = 0.025$ (see Figure 1). Reading scores were virtually identical for the control and ILS groups, but mathematics scores were dramatically higher for the ILS versus the control group.

TABLE 2. MANCOVA for CTBS Reading and Mathematics Tests.

SOURCE	SS	df	MS	F	p
Between-subjects					
ILS/no ILS	3918.386	1	3918.386	12.193	0.001
Cov (R)	20865.412	1	20865.412	64.928	0.000
Cov (M)	3319.660	1	3319.660	10.330	0.002
error	26030.328	81	321.362		
Within-subjects					
Content	310.116	1	310.116	1.425	0.236
Content * ILS	1135.134	1	1135.134	5.217	0.025
XX * Cov (R)	2750.762	1	2750.762	12.643	0.001
XX * Cov (M)	2975.126	1	2975.126	13.674	0.000
error	17623.648	81	217.576		

Unadjusted effect sizes were calculated by taking the difference between the treatment and control groups and then dividing by the standard deviation of the control groups. Mathematics scores increased under ILS ($es = 0.49$) but reading scores ($es = 0.06$) increased only minimally (*adjusted* effect sizes for Mathematics 0.66, for Reading 0.20).

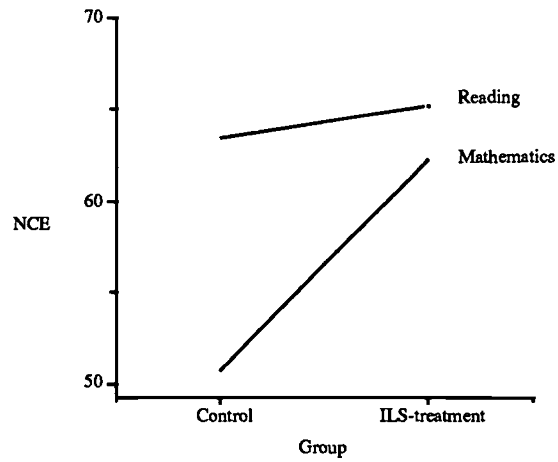

Figure 1. Interaction between treatment and content.

Discussion

The findings of this study confirmed that gains in mathematics scores were greater than gains in reading scores. The effect sizes obtained for this long duration ILS study were $es = 0.49$ for mathematics and $es = 0.06$ for reading. This amounts to a gain of about 2 NCEs in reading and 11 NCEs in mathematics for the ILS group over the control group.

Note that there are several factors that suggest that these effects sizes are under-reported: (a) the class size of the control group, 16 students per teacher, was 23% smaller than that of the ILS group, about 24 students per teacher. Thus the control should out-perform the ILS group. (b) Further, based on second grade tests, the control group was brighter than the ILS group, so their third grade scores should be greater.
(c) Another vexing issue is that the ILS instruction did not perfectly correlate to the standardized test content, thus "watering down" larger potential gains. And finally,
(d) these learning gains represent long-term retention.

This study hypothesized that "good" CBI mathematics instruction may obtain larger gains than "good" CBI reading because the nature of mathematics content more closely corresponds to CBI media attributes. The findings of this study could be interpreted as supporting this hypothesis. Obviously, this requires more rigorous investigation.

As indicated above, the teacher is a critical variable in longitudinal studies of achievement gains. Teacher expectations, either positive or negative, regarding the implementation of an ILS (or CBI in general) may impact that teacher's behaviors before and during the implementation. For example, a teacher may intentionally "try harder" during the implementation of a new instructional method like ILS, with a likely positive impact on learning performance. Alternately, if the teacher is negative or even indifferent, this response may transfer to students, with a likely negative impact on learning and thus on posttest performance. In this study, the second scenario is more likely than the first, though both probably occurred to some extent.

Interestingly, follow-up interviews indicated that this teacher focused on reading during regular classroom instruction both before and with the ILS. Emphasizing reading at the expense of mathematics (and other subjects) may be common in many elementary classrooms (Ball, 1988; Burns & Lash, 1988; Grouws & Good, 1988). The ILS instruction possibly compensated by providing an alternative coverage of mathematics content. In the same way, if a teacher focused on mathematics in the classroom, then an ILS may positively affect reading scores.

The ILS provided an alternative coverage of mathematics...

In summary, no one instructional method is appropriate for every learner under every circumstance. An ILS, like any good instructional method, provides an alternative and supplement to classroom presentations. An ILS is only a part of the total learning environment but may change any or every aspect of this environment. ILS research should focus on how an ILS can change the total learning environment (i.e., curriculum coverage, interpersonal-interactions, motivation, remediation, parental involvement) and must consider teacher effects.

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Appendix A - Data Set

Group	R2	R3	M2	M3
Control	63	57	52	40
Control	53	48	88	56
Control	71	55	81	73
Control	95	99	94	70
Control	99	89	98	89
Control	63	69	99	40
Control	92	85	98	75
Control	95	92	99	94
Control	75	73	94	77
Control	35	39	13	13
Control	46	43	49	24
Control	89	95	71	66
Control	99	73	98	75
Control	98	66	76	18
Control	61	70	64	75
Control	85	78	62	73
Control	89	59	74	58
Control	85	97	81	38
Control	93	89	48	40
Control	21	14	51	23
Control	29	9	71	26
Control	79	92	74	53
Control	70	59	68	43
Control	43	42	43	21
Control	38	47	51	34
Control	85	52	95	75
Control	80	92	65	75
Control	79	78	30	38
Control	80	95	68	69
Control	80	59	81	55
Control	80	89	62	61
Control	75	49	68	34
Control	28	29	53	2
Control	12	2	13	6
Control	89	62	89	73
Control	28	20	43	43
Control	43	78	84	61
Control	66	74	48	38
ILS	86	82	74	92
ILS	89	85	55	89
ILS	61	55	71	75
ILS	33	24	10	56
ILS	24	39	55	47
ILS	50	65	34	40
ILS	23	57	5	18
ILS	35	27	62	77
ILS	55	51	88	52
ILS	22	10	52	25
ILS	50	33	46	75
ILS	33	59	31	28
ILS	78	60	62	52
ILS	63	39	94	39
ILS	95	98	81	89
ILS	67	95	81	52
ILS	82	97	23	47
ILS	55	82	74	61
ILS	86	65	74	83
ILS	44	39	49	27
ILS	75	39	74	75
ILS	61	51	37	45
ILS	75	33	58	54
ILS	93	97	81	91
ILS	57	70	35	36
ILS	53	55	81	63
ILS	93	99	86	95
ILS	61	89	89	82
ILS	80	82	81	53
ILS	89	74	89	93
ILS	39	29	25	30
ILS	80	62	64	47
ILS	93	66	95	91
ILS	89	92	68	78
ILS	45	74	89	93
ILS	35	35	46	35
ILS	31	22	23	26
ILS	85	89	84	71
ILS	70	92	62	95
ILS	75	66	91	82
ILS	75	74	64	10
ILS	98	92	97	99
ILS	33	59	56	63
ILS	99	97	98	93
ILS	89	92	97	89
ILS	70	78	51	45
ILS	70	97	84	75

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