Instructional Technology for Reading Remediation in Rural Settings: An Examination of Effectiveness and Efficiency

Benjamin Solomon, Ph.D.
University at Albany, State University of New York

Brit'ny Stein, Ph.D.
Osage County Interlocal Cooperative

Chase Kitterman, M.S.
Oklahoma State University

Debbie Enos, M.L.I.S.
Osage County Interlocal Cooperative

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Background & Context

Instructional technology has undergone drastic expansions of commercialization and user accessibility. Such approaches are used to automize and standardize routine remedial procedures that otherwise would be cost-prohibitive. These advantages are particularly relevant in rural settings, where funding is scarce and recruitment of qualified interventionists difficult. Despite these advantages, researchers have expressed concern regarding the explosion of marketed options (Hammerschmidt-Snidarich et al., 2019), particularly concerning its use with vulnerable students, such as those shown to be at-risk for deficits in reading.

Marketed instructional technology runs the gamut, from rudimentary, colorful apps to well-developed interactive programs that scaffold content across grade levels. Two examples of the latter are *iStation* (2019) and *Lexia* (2019), both of which are the products of large development teams. These adaptive programs are marketed to schools as a supplement to traditional instruction, and as a remedial strategy for children at-risk, although scarce research exists on their effectiveness. Even rarer are analyses of program efficiency, where a program's measured effect on target student behavior is divided by the time required to implement: a rate of improvement (Skinner et al., 1996) standardized by a unit of instructional time (IT). This is particularly relevant for complex programs of varied components, like *iStation* and *Lexia*.

Purpose & Research Questions

The purpose of the current study is to evaluate the relative effectiveness and efficiency of *Lexia* and *iStation* against a business-as-usual condition (BAU). Our specific research questions were:

- Does the implementation of *Lexia* and/or *iStation* for rural students at-risk for reading deficits result in gains in literacy beyond that observed for BAU?
- Which program produces the greatest gain in literacy when IT is considered (i.e., efficiency)?

Participants & Setting

The two participating schools were mid-western rural public elementary schools in neighboring districts. Both schools had student populations between 200 and 300 and were indexed as low performing schools with high levels of economically disadvantaged students. Students eligible for study inclusion were initially identified as at-risk via the school's respective fall literacy screening. Researchers independently verified that each student was at-risk when collecting pre-test data.

Interventions

Lexia and *iStation* share many common characteristics, including explicit acknowledgement of Common Core standards and instruction themed around the five pillars of the National Reading Panel (2000). Further, they both utilize individualized assessment which inform customized lessons of varied content, pacing, and presentation. They also produce paper-based supplements for teachers to execute when students exhibit non-responsiveness to individual lessons. Intervention sessions ran five days a week for about 20-30 minutes in small

groups. If supplemental instruction was recommended, it was carried out by the facilitating teacher daily after these sessions.

Design

This study utilized a fully experimental 3(conditions) x 2(time points). The two schools were randomized to intervention condition, and within each of these schools, eligible students were randomized to either the BAU, which was typical small-group instruction run by one teacher and several assistants, or the assigned intervention condition. In both schools, 24 students were assigned to the school's respective experimental condition and 24 to the BAU condition (48 total in BAU).

Data Collection & Analysis

Students were administered the following clusters of the Woodcock-Johnson IV (WJ): Broad Reading, Basic Reading, and Reading Fluency. Further, select CBMs were administered from the *Fastbridge* family: readingCBM, a measure of reading fluency, and COMPeffeciancy, a measure of reading comprehension.

We conducted a factorial ANOVA. Second, we examined time spent in intervention so as to better understand the relative efficiency of each of the intervention procedures. In addressing the latter, we considered running (a) time allocated for the intervention to be implemented as recommended and completion of program worksheets (for intervention conditions). Time spent in intervention was precisely timed either by implementors (in the case of BAU and completion of worksheets) or by the programs themselves.

Findings & Results

Results of the ANOVA examining results across schools (i.e., *iStation* vs. *Lexia* vs. pooled BAU group) are shown in Table 1. There was a main effect for time for WJ Broad Reading scores, WJ Reading Fluency scores, and readingCBM after family-wise error correction. There was no observed main effect for condition nor the interaction of time and condition. Given that all conditions exhibited similar effects on student learning, we looked at time spent in intervention descriptively across the conditions. This analysis is summarized in Table 2. It can be seen that the BAU groups and *iStation* required comparable amounts of time, although *iStation* permitted a much larger student to teacher ratio. *Lexia*, on the other hand, required less than half the amount of time to implement with fidelity relative to *iStation*. This was primarily due to the reported spillover time required to implement *iStation* supplemental lessons with fidelity beyond the recommended allocated time.

Conclusions

In summary, there was a main effect for time across conditions. That is, all conditions resulted in observed growth, and thus the intervention programs performed comparably to BAU, which was traditional intervention. This is promising but not overwhelming evidence in favor of *iStation* and *Lexia*. However, the analysis of instructional time yielded interesting and relevant data: *Lexia* was highly efficient relative to all other conditions, primarily due to the ease of completing supplemental materials relative to *iStation*. Thus, when results are conceived as rates of learning, Lexia was superior. This was supported by anecdotal evidence: the Lexia teacher reported satisfaction with the product while the teacher running *iStation* expressed frustration at the needed time to prepare and execute supplemental lessons.

References

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Table 1.
Results of the Factorial ANOVAs

	F	*df*	*p*
WJ Broad			
Time	28.08	73 (1)	< .01*
Group	1.43	73 (2)	.53
Time x Group	.64	73 (2)	.25
WJ Basic			
Time	2.62	67 (1)	.11
Group	.78	67 (2)	.46
Time x Group	.36	67 (2)	.70
WJ Fluency			
Time	36.47	64 (1)	< .01*
Group	1.93	64 (2)	.15
Time x Group	.77	64 (2)	.47
R-CBM			
Time	181.11	79 (1)	< .01*
Group	.98	79 (2)	.38
Time x Group	2.73	79 (2)	.07
Compeff			
Time	3.80	47 (1)	.06
Group	2.08	47 (2)	.14
Time x Group	.19	47 (2)	.83

* = significant after family-wise error correction across DV families (Benjamini-Hochberg procedure)
Note. Because each DV had grade restrictions, and could not be measured for every student involved, ANOVA was chosen over MANOVA due to issues with listwise deletion.

Table 2.
Analysis of Instructional Efficiency

Group (# Interventionists)	Cum. minutes implemented[a]	Avg. cum. minutes per student	# of days implemented
iStation (1)	9939	414.13	88
Matched Control A	28160	469.33	88
Lexia (1)	4410	155.01	99
Matched Control B	19090	333.86	99

[a] This represents the recommended allocated time for intervention (*Lexia* = 45, *iStation* = 40) and additional time, reported by the teacher by day, required to implement supplemental intervention when recommended by the program ($\bar{X}_{istation} =$ 88.48; Lexia required no additional time).