A Study of the Effectiveness and Cost of AEL's Online Professional Development Program in Reading in Tennessee

Linda Cavalluzzo
David Lopez
John Ross
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with Miguel Martinez

December 2005

Appalachia Educational Laboratory (AEL)

at

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Executive Summary

In 2002, the Tennessee Department of Education asked the Appalachia Educational Laboratory (AEL) at Edvantia, Inc. to develop content for online professional development that would help meet the goals of the state's Reading First program. In response, laboratory staff developed and subsequently delivered *Assessment and Intervention in a Comprehensive Literacy Classroom*, a five-module course delivered over 16 weeks. The course was designed to help K-3 teachers, K-12 special education teachers, and building-level administrators incorporate formal and informal assessments into their reading instruction and use the results of those assessments to guide instruction. The course was organized and delivered in five modules that covered the following topics: (1) a conceptual model of a comprehensive literacy classroom in which all children can learn to read by the end of the third grade; (2) the five essential elements of reading instruction; (3) the Tennessee assessment system and the four types of assessments (screening, diagnosis, outcome, and progress monitoring); (4) assessment instruments, implementation steps, and practice opportunities; and (5) use of assessment data to guide planning, grouping for instruction, and selection of instructional strategies (Ross, Thigpin, Cavalluzzo, Guzman, & Patterson, 2004).

The course was initially delivered in the spring of 2004 to staff at 56 elementary schools in Tennessee that received Reading First grants. Researchers at The CNA Corporation (CNAC) collaborated with the course developers and implementers to conduct a formative assessment of the online course. The first assessment report (Ross, et al., 2004) examined qualitative data from four sources for each of the participating schools: (1) online evaluations by course participants, (2) threaded discussions of course participants, (3) focus groups of literacy leaders, and (4) discussions with literacy leaders. These data revealed high levels of satisfaction with the content of the training modules. In addition, statistical comparisons of teacher test scores before the program began and after the completion of each module found substantial improvements in teacher knowledge in each area.

Formative evaluation also identified two problems with the delivery of the course: (1) introduction of the program in the middle of the school year and (2) technology and software difficulties experienced at the school level. As a result of this evaluation, the Tennessee Department of Education shifted the program introduction to the beginning of the school year for subsequent administrations of the course. The technology issues were often school-based and related to outdated hardware and software and limited bandwidth. These issues were most often addressed through communications between Edvantia technical support staff and district or school technology support staff.

This paper extends the prior analysis in two ways. First, it revisits the pre- and posttest data to estimate the effect size associated with teacher participation in the online program and examines changes in student outcomes in the 56 Reading First schools relative to a sample of matched comparison schools. Second, the paper offers a cost analysis of development and delivery of the online program and compares it to the projected cost of delivery of the same materials through face-to-face workshops. The paper considers these costs from the perspectives of (1) the developer; (2) the state, which paid for course development; and (3) the schools, which purchased course seats for their teachers.

Findings

      Impact on teacher knowledge. Researchers found strong evidence that the online professional development course had an immediate and important impact on teacher knowledge pertaining to the use of assessments to guide literacy instruction. Comparisons of test scores prior to and immediately following completion of the training modules showed that overall scores increased 21 percentage points on average. The effect size associated with this improvement is 1.6 standard deviation units, a magnitude that is widely recognized as large and important in the field of education (Cohen, 1988).

      Impact on student achievement. Due to limitations in the public availability of 2005 state student achievement data, researchers were not able to fully explore the relationship between teacher gains from participation in the online course and their students' academic achievement. However, researchers did compare schools that received the professional development training to a matched sample of control schools in which teachers did not receive training. Specifically, researchers assessed whether the Reading First intervention schools, compared to non-Reading First control schools, differed in the proportion that met the state and federally mandated 2003, 2004, and 2005 adequate yearly progress (AYP) goals. While both the intervention and control schools dramatically improved their ability to achieve AYP between 2003 and 2005, the improvement was larger for intervention schools. This suggests a positive impact of the reforms in the Reading First schools. Due to the timing of the delivery of the online course and in-school improvement, however, the relationship between the intervention and the observed improvement is unclear. Once 2005 state test scores for reading become available by grade level and school, it will be possible to revisit the question of intervention impact on student achievement.

      Cost effectiveness. The analysis of cost data shows that providing the online course is an inexpensive way to furnish professional development and compares favorably to projected costs associated with face-to-face delivery of the same materials. Moreover, a key design feature of the online program is that it spreads instruction over a 16-week period. The least expensive face-to-face instruction, in contrast, would require a five-day training session to cover the same materials. However, delivery of professional development in short bursts, rather than over time, has been shown to have little or no effect on teaching practices (Supovitz, 2002).

      Alternatively, face-to-face instruction could be delivered over time using a train-the-trainer approach. Such an approach would be most similar to the online design but would be substantially more expensive to implement if trainers had to travel long distances, as they would in Tennessee, to receive training in five intervals. Moreover, the evidence assembled here suggests that the online program resulted in large improvements in teacher knowledge and was substantially more costeffective when compared to face-to-face instruction.

Introduction

Online professional development is a subset of distance learning in general and, as such, has seen tremendous growth in terms of technologies, pedagogy, and research over the past 10 years. In this past decade, numerous colleges and universities have undertaken efforts to make their entire graduate and undergraduate course catalogues available online, and new virtual universities, such as the University of Phoenix and Western Governors University, have become major degree-granting institutions. Virtual high schools have been established—either for profit or as extensions of public school offerings—in more than a dozen states. Online professional development has become a substantial growth market. Despite this, there is little indication in the experimental research literature of the relationship between cost and effectiveness of online professional development. Some measures used in evaluating distance learning in general include student outcomes as well as faculty and student perceptions (Ramage, 2002).

The concept of online learning, or e-Learning, as it is sometimes called, has received support from the U.S. Department of Education for its ability to help schools achieve several goals of the No Child Left Behind Act. These include providing increased access to high-quality professional development for teachers, paraprofessionals, and principals as required specifically by Title II of the Act and by many subsections throughout the law (e.g., Reading First, Enhancing Education through Technology). The July 12, 2002, press release from the U.S. Department of Education, *Paige Touts Technology, E-Learning on His No Child Left Behind Tour Across America* (U.S. Department of Education, 2002) and the review of the July 21, 2003, forum from the American Youth Policy Forum, *Online teaching, online learning: A cost effective choice for states?* are but two accounts from John Bailey, former director of educational technology at the U.S. Department of Education, and former Education Secretary Rod Paige that support e-Learning. Additional support for online professional development by Department personnel can also be found (Bailey, 2002; Bailey, 2003; Plato, 2003).

The reauthorization of the Elementary and Secondary Education Act, otherwise known as the No Child Left Behind Act (NCLB) of 2001, creates opportunities and challenges for schools. One opportunity is increased funding for state-designed literacy grants through Reading First. With this funding, states can design and offer reading programs to improve the skills of K-3 principals and teachers and K-12 teachers of special education. Concomitant with this opportunity is the challenge of the Reading Excellence Act (REA) of 1999 that all schools have highly qualified teachers by 2006. To meet this challenge, teachers can turn to college coursework or professional development. States with a significant number of rural school districts, such as Tennessee, are seeking nontraditional solutions to providing high-quality, research-based professional development so teachers do not need to leave their homes and classrooms for extended periods of time to travel to distant institutions to hone and develop skills. Tennessee chose to provide professional development via distance learning and turned to the Appalachia Educational Laboratory (AEL), at Edvantia, to develop and deliver a course. The course *Assessment and Intervention in a Comprehensive Literacy Classroom* was the result of this collaboration.

This paper examines evidence of the effectiveness and costs of the course, based on implementation in 56 schools in the spring of school year 2003-2004. The analysis focuses on

three areas: (1) the impact of online professional development on teacher learning, (b) the impact of online professional development on student achievement, and (3) the overall cost effectiveness of online professional development. The goal of this analysis is to help educators, policymakers, and other stakeholders make informed decisions about online professional development and determine under what circumstances it is most effective.

Characteristics of Effective Professional Development Models

Professional development has been broadly defined by the U.S. Department of Education (1996) as "the rigorous and relevant content, strategies, and organizational supports that ensure the preparation and career-long development of teachers and others whose competence, expectations, and actions influence the teaching and learning environment" (p. 1). This statement conveys the important role of professional development in the advancement of learning. Its importance is further underscored by the amount of literature that exists on the topic. Over the past two or three decades, several attempts have been made to synthesize this material, but the task continues to become more difficult as the number of methods and professional development models proliferate (Sparks & Loucks-Horsley, 1989; Sprinthall, Reiman, & Theis-Sprinthall, 1996).

While many studies have looked at what constitutes effective professional development for teachers, very little of the research can be verified statistically through empirical data (Wilson & Berne, 1999). Part of the explanation for the scant number of empirical studies can be explained by the difficult and complicated nature of social sciences research. However, the 2001 No Child Left Behind reform blueprint (NCLB, 2002) has established high standards for the professional development of America's teachers by requiring states and school districts "to ensure that federal funds promote the use of scientific, research-based and effective practice in the classroom" (p. 13).

In 2005, the Appalachia Educational Laboratory (AEL) conducted a review of existing empirical studies of both face-to-face and online professional development programs for the period of 1985 to 2005 (Larson, in press). More than 100 abstracts, articles, reports, and dissertations were analyzed to find studies with conclusions based on research designs that were either experimental or quasi-experimental with a matched control group and clearly defined data measures. Twenty-one of these studies met the criteria for inclusion in this analysis of the components that make up effective professional development programs. A full list of these 21 research projects is provided in Appendix A. Evidence was gathered to support the identification of nine components of effective professional development as extracted from the 21 studies. Some components were supported by more evidence than others, as illustrated in Table 1. The nine components identified indicate that effective professional development is

1. linked to student learning outcomes
2. job embedded
3. ongoing and sustained, with follow-up
4. incorporates authentic, active learning experiences
5. includes subject-matter content
6. encourages reflection on pedagogy, content, and beliefs

7. incorporates collaboration with colleagues and/or experts
8. provides support for teachers
9. measures impact on student achievement

Table 1.
Effective Professional Development Components and Corresponding Numbers Supporting Studies

Professional Development Components	Number of Supporting Experimental Studies	Number of Supporting Quasi-Experimental Studies	Total Number of Supporting Studies
Linked to student learning outcomes	5	13	**18**
Job embedded	5	13	**18**
Ongoing and sustained, with follow-up	5	8	**13**
Incorporates authentic, active learning experiences	6	11	**17**
Includes subject-matter content	7	13	**20**
Encourages reflection on pedagogy, content, and beliefs	7	14	**21**
Incorporates collaboration with colleagues and/or experts	5	12	**17**
Provides support for teachers	6	10	**16**
Measures impact on student achievement	5	11	**16**

Evidence of the Effectiveness of Distance and Online Instruction Versus Face-To-Face Instruction

Educators, policymakers, and other decision makers have raised concerns about what comprises online professional development, the infrastructure it requires, and its costs and benefits—especially when compared to face-to-face delivery (Richardson, 2001; Watkins, 2003; Yoder, 2001). Common concerns relate to whether online professional development is as effective as face-to-face delivery or whether participants in online professional development may feel isolated. Benefits are also mentioned, such as greater availability of topics, convenience and flexibility in scheduling, and more opportunity for follow-up—often through participation in online learning communities.

More than 2,000 studies can be identified that deal with distance education. However, most focus on courses for academic credit—graduate, undergraduate, and even high school courses. Distance-based professional development opportunities are generally absent from the research literature (Bernard et al., 2004, p. 390). Nonetheless, several studies suggest that there is no significant difference between the outcomes of online and face-to-face instruction. Ryan (2002), in the study of one undergraduate mathematics course, found no significant difference, as measured by final grade, between classroom, telecourse, and Web-based delivery systems. Expanding the scope of the study to the college's entire catalog of distance education offerings, the investigator again found no significant statistical difference in either the attrition rates or the grade point averages of the participants in online courses compared to those in face-to-face settings. Karr, Weck, Sunal, & Cook (2003) compared student performance in a graduate

engineering mathematics course that was offered online, traditionally, and as a hybrid online/in-class experiment. Assessing student performance on three tests, one final examination, and homework assignments, the researchers concluded that mode of delivery had little impact on student outcomes.

A meta-analysis by Bernard et al. (2004) provides a comprehensive survey of the empirical literature that compares distance learning and classroom instruction.[1] In all, achievement, attitude, and retention outcomes from 232 studies were analyzed. The researchers found that the literature often lacked depth, stating: "Nearly 60 percent of codable study features, including methodological features, were coded as missing" (p. 407). The investigators also rated the methodological quality of the literature as "weak," noting that field experiments are "often conducted in circumstances in which opportunities to control for rival explanations of research hypotheses are minimal" (p. 407). The survey suggests that "many applications of DE [distance education] outperform their classroom counterparts and that many perform more poorly" (p. 379). The Bernard et al. (2004) meta-analysis generally supports the claim that effective distance education depends on the provision of pedagogical excellence.

AEL's Tennessee Online Professional Development Course

Developers report that the Tennessee professional development course in reading was designed to provide an online experience that capitalized on the best research available. Special attention was paid to developing learning communities, addressing the needs of adult learners, and to emphasizing reading-specific content and skill acquisition over technical skills. Guidelines for content development included internally developed instructional design guidelines, as well as application of Keller's (1987, 1999) ARCS model of motivational design (presented later).

Based on Edvantia's 40 years of experience in the effective delivery of professional development and the work of organizations like the National Staff Development Council (2001), an internal work group developed instructional design guidelines for professional development that influenced the development of the online content (Table 2). These standards emphasize effective strategies such as the development of learning communities, providing sustained support over time, and acknowledging the needs of adult learners, regardless of delivery mode.

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[1] The primary methods of delivery in distance education have changed at least five times over 20 years (Taylor, 2001). Bernard et al.'s analysis encompasses these technologies.

Table 2.
Instructional Design Guidelines

Guideline	Description
Framework	Learners are better able to make connections and derive personal meaning from content when the instructional design includes a framework or structure for that content.
Evidence	Adult learners look for an evidence base when they approach a new learning experience.
Relevance	Relevant content and opportunities for practical applications enhance adult motivation and learning.
Community	Learning occurs best in community.
Time	Learning occurs over time.
Learner background and preference	Effective learning designs acknowledge and accommodate the diverse backgrounds, interests, and learning styles of adults.
Activities	An appropriate balance of content structuring (presentation); personal reflection; interaction with colleagues; and hands-on, or applied, learning enhances adult motivation and engagement.
Assessments	Formative assessment is integral to participant learning and improving the instruction.

Because of a history of low completion rates for self-paced instruction, the Tennessee Department of Education and the course developers decided not to employ completely self-paced instruction during the implementation. Building on the learning community metaphor, the state designated master teachers at each school (called "Literacy Leaders"), who received training during the year on a variety of topics related to reading instruction and assessment. These Literacy Leaders served as facilitators for their own learning communities, thereby creating what might be referred to as "group self-paced instruction," as each community enforced its own timeline, level of participation, and acceptable levels of content mastery. The content included structures intended to guide the Literacy Leaders, as well as face-to-face and online orientation programs, which presented guidelines for obtaining requisite administrative and technical support, developing and keeping a timeline, and facilitating online learning.

ARCS Model. Developed by Keller (1987), the Attention, Relevance, Confidence, and Satisfaction (ARCS) model of motivational design is widely used in the development of instruction in multiple formats (Small, 1997), including computer-based instruction and distance education (Keller, 1999). Each of the ARCS components is subdivided into three subcomponents (for an overview of components, see Small, 1997).

To gain student attention, provide relevant content and activities, build confidence, and offer opportunities for success the ARCS model was reflected in several facets of the instructional design of the course. These include the structure, chunking, and sequencing of the content; the design and implementation of the activities; and the selection of media and alternate media formats that sought to satisfy a variety of platforms, processing capacities, and connection speeds. The participants' experience and current practice were critical factors as the school-based communities reviewed findings from research, explored their own practices, and

constructed new knowledge within the context of their professional learning communities. The activities in each module often followed a three-part progression, beginning with (1) reflection on initial practice, followed by (2) exploration of new concepts, and concluding with (3) synthesis of new skills and knowledge with current practice. These activities resulted in strategies or processes to apply within the school or classroom. The content of the online course included text, graphics, videos, and animations delivered via the course management system software.

The next section of this report turns to an analysis of the effectiveness of the online course. Because the course has not been implemented in a face-to-face mode, the researchers assume, based on the review of the literature, that the face-to-face course would be equally effective if implemented in a comparable way—that is, as an ongoing process that engages a group of teachers in the learning experience.

Indicators of Course Effectiveness

To draw conclusions about the effectiveness of the online program, this section presents a review of the results from analyses of data related to teacher learning. A comparison of online and face-to-face delivery within the framework of the nine effective components identified through a review of the professional development research literature is also provided.

Teacher Learning

Researchers used pre- and posttests developed for the course to examine the impact of each module on participants' understanding of the materials. The tests developed for the course consist of one 68-question pretest and a matched series of five posttests totaling 68 questions. Questions on the pretest and each posttest correspond to the learning objectives for the five modules. A total of 1,270 classroom teachers and administrators took the online module tests. Of these, 693 participants completed all pretest and corresponding posttest questions. Based on this sample, the average pretest score was 64%. Average pretest scores across modules ranged from a low of 51% in Module 4 (assessment instruments) to a high of 75% in module 5 (use of assessment data to guide planning, grouping for instruction, and practice opportunities). Taken together, scores improved an average of 21 percentage points across all five Modules, with the greatest gains in Modules 4 (31 percentage points) and 3, which dealt with the assessment process and types of assessments (27 percentage points). Posttest average scores, shown in Table 3, were greater than 80% for every module. Researchers conducted paired t-tests of pre- and posttest scores to confirm the statistical significance of these results. For each module and for the 68 questions overall, the gains were significant ($< .01$). In addition, using Cohen's d, researchers assessed the magnitude of the pre-post differences for each module and across the full set of 68 items. Analyses on the overall pre-post scores revealed an effect size of 1.6 standard deviation units. For specific modules, effect sizes ranged from a low of .75 for Module 5 to a high of 1.43 for Module 3. Effect sizes of .8 standard deviations or more are widely regarded as large in the field of education (Cohen, 1988). Using this guideline, the intervention appears to have been quite successful. Table 3 presents average pretest and posttest scores and percentage gains by module.

Table 3.
Participants' Pre- and Posttest Scores by Module (N = 693)

	Module 1	Module 2	Module 3	Module 4	Module 5	Total % Correct
Correct pre	63%	64%	61%	51%	75%	64%
Correct post	83%	83%	89%	82%	88%	85%
Percentage point gain	20	19	27	31	13	21
t test	27.48	27.59	37.58	32.85	19.78	42.49
Effect size	1.04	1.05	1.43	1.25	.75	1.62
N of questions	12	20	13	9	14	68

Impact of Training on Student Achievement

To examine the impact of the training on student achievement, the initial plan was to compare schools receiving training to a set of matched comparison schools on their third-grade Dynamic Indicators of Basic Early Literacy Skills (DIBELS), Tennessee Comprehensive Assessment Program (TCAP), and Tennessee Value-Added Assessment System (TVAAS) scores. DIBELS data were not made available for the study. At the time of this report, the 2005 TCAP and TVAAS data are not publicly available. Instead of these data, the researchers used the schools' Adequate Yearly Progress (AYP) ratings in 2003, 2004, and 2005 as crude indicators of improvement in student performance that may have been influenced to some degree by teacher participation in the online professional development course in reading.

Preceding from the assumption that professional development impacts student achievement through improvements in teacher knowledge, which enhances classroom practices and, subsequently, student outcomes, the researchers considered the potential for impact of the intervention on the AYP status of each school. Given the importance placed on attaining AYP under No Child Left Behind, this outcome is important to examine in the overall context of the effectiveness of any Reading First program. However, a wide variety of factors affect a school's ability to achieve AYP, and multiple reforms may have been introduced to improve outcomes in the Reading First schools. Furthermore, AYP data are presented at the overall school level and not by individual grade in school. Therefore, these analyses are only suggestive of the impact that the course may have had on student literacy.

For the following analyses, researchers matched each of the 56 schools that participated in the reading course with a comparison school from within the same county, and then compared schools on three variables: (1) percentage of White students (2) percentage of economically disadvantaged students, and (3) overall school size. The data for selecting the comparison schools were collected from the SchoolMatters Web site (http://www.schoolmatters.org). For one of the 56 schools, general demographic and student performance information were not publicly available. Therefore, the school was omitted from subsequent analyses. Researchers conducted paired sample *t* tests on the 55 matched schools to confirm that the intervention schools were similar to their matched comparison schools on the dimensions specified. As shown in Table 4, the analyses revealed no significant differences, on average, between the intervention schools and their matched counterparts on the three selection variables; on average, the

percentages of White students and economically disadvantaged students were in each type of school within five percentage points of each other.

Outcome data reported in this analysis are from the Tennessee Department of Education 2003 and 2004 Report Cards. Between 2003 and 2004, the state instituted a new test of student performance and redefined the benchmark by which AYP is assessed. Although a potential confound for this analysis, these changes are assumed to influence the intervention and control schools to the same degree. Therefore, any observed differences between intervention and control schools are suggestive of a possible impact of the Reading First intervention.

Table 4
Means and Standard Errors of Selection Variables for Schools Receiving Training and Matched Comparison Schools

	Schools Receiving Training	Matched Comparison Schools	paired samples *t* test (df = 54)	*p*
Percentage of White Students	32.0%	33.7%	-0.79	>.05
Standard Error	*5.0%*	*4.7%*		
Percentage of Economically Disadvantaged Students	85.3%	83.8%	0.80	>.05
Standard Error	*1.7%*	*1.8%*		
School Size	403. 5	448.9	-1.93	>.05
Standard Error	*26.6*	*26.5*		

Analyses were conducted in two parts. First, researchers compared the proportion of intervention schools making AYP to the proportion of comparison schools making AYP for each of the three years (2003, 2004, 2005). Second, they conducted separate analyses for intervention and comparison schools to assess any longitudinal change in the proportion of schools making AYP. For all reported analyses, the McNemar chi-square test was used. The McNemar test is a common nonparametric test for two related dichotomous variables (Armitage & Berry, 1994; Liddell, 1983) and appropriate for the analysis of both matched pairs and repeated-measures dichotomous data. This test is particularly useful for detecting changes in responses due to experimental intervention in before-and-after designs. Finally, all reported test statistics are from the marginal homogeneity test, which is an extension of the McNemar test. This statistic tests for changes in response using the chi-square distribution and is useful for detecting response changes due to experimental intervention in before-and-after designs. To facilitate understanding and interpretation, the data are presented in terms of the percentage of intervention or comparison schools that achieved AYP in a given year. Figure 1 shows the percentage of intervention and comparison schools making AYP in the preintervention year (2003), intervention year (2004), and postintervention year (2005).

Comparison of Intervention to Control Schools

Analyses revealed that in the pre-intervention year (2003), intervention schools had a significantly lower probability of making AYP (Achieved AYP = 12%) compared to comparison schools (Achieved AYP = 36%), $\chi^2_{(1)} = 8.33$; $p < .006$. In the intervention year (2004), analyses revealed no significant differences between the intervention schools (Achieved AYP = 76%) and comparison schools (Achieved AYP = 74%), $\chi^2_{(1)} = 0.09$; $p > .05$. Finally, in the postcomparison year (2005), analyses also revealed no significant differences between the intervention schools (Achieved AYP = 82%) and comparison schools (Achieved AYP = 93%), $\chi^2_{(1)} = 2.00$; $p > .05$.

Percentages of Schools Making AYP
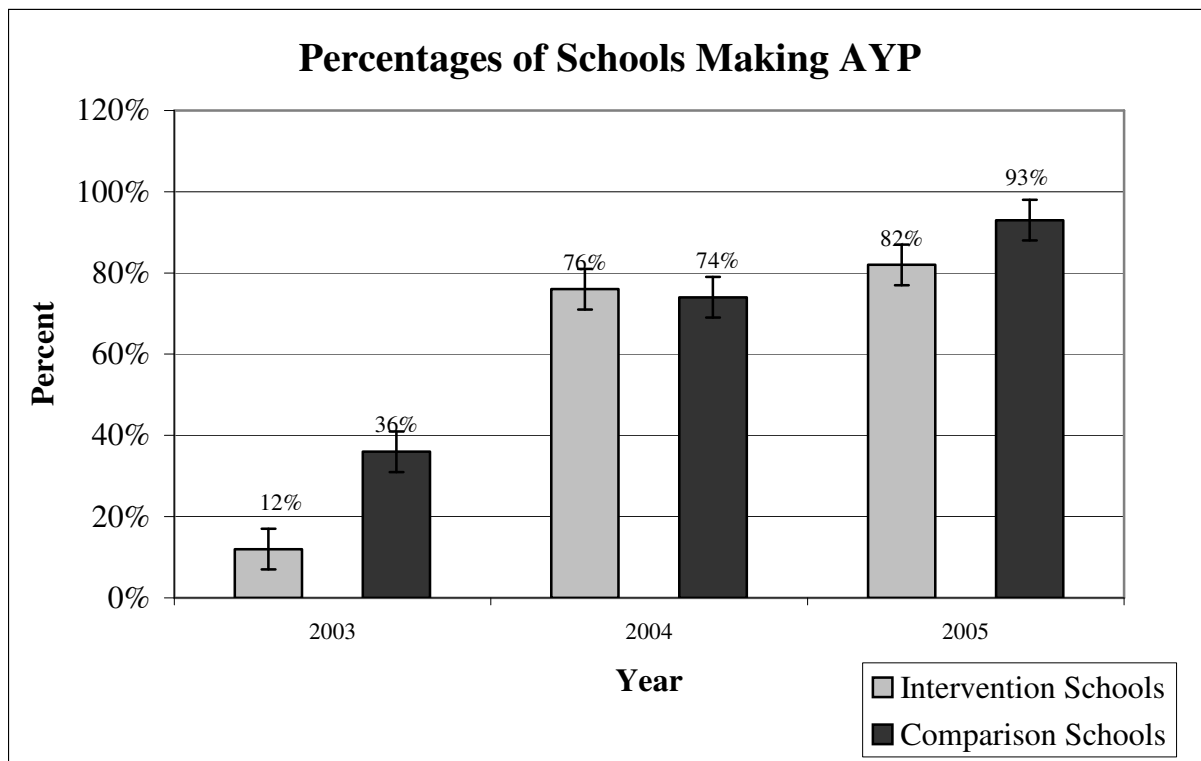
Figure 1
Percentages of Intervention and Comparison Schools Making AYP in 2003, 2004, and 2005

Longitudinal Changes in Making AYP

Intervention schools. Analyses revealed a statistically significant increase in the proportion of intervention schools that achieved AYP in 2004 Achieved AYP = 76%) compared to those that achieved AYP in 2003 (Achieved AYP = 12%), $\chi^2_{(1)} = 31.00$; $p < .0001$. Analyses also revealed no statistically significant differences between the postintervention year, 2005 (Achieved AYP = 82%) and the intervention year, 2004 (Achieved AYP = 76%), $\chi^2_{(1)} = 2.27$; $p > .05$.

Comparison schools. Analyses revealed no statistically significant differences between the proportion of comparison schools that achieved AYP in 2004 (Achieved AYP = 74%) and to those that achieved AYP in 2003 (Achieved AYP = 36%), $\chi^2_{(1)} = 1.00$; $p > .05$). Analyses also

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revealed no significant differences between the postintervention year, 2005 (Achieved AYP = 93%), and the intervention year, 2004 (Achieved AYP = 74%), $\chi^2_{(1)} = 0.14$; $p > .05$.

In summary, the matched comparison analyses revealed significant differences between the intervention and comparison schools. First, direct comparisons between the intervention and comparison schools revealed that intervention schools had a significantly lower probability of achieving AYP in 2003. However, no significant differences were observed between intervention and comparison schools in either the intervention (2004) or postintervention (2005) years. That is, the probability of intervention schools achieving AYP did not significantly differ from that of the comparison schools following the online training. Second, significant differences between intervention and comparison schools were also observed in the longitudinal analyses. For the intervention schools, the probability of achieving AYP significantly increased from the preintervention (2003) to the intervention year (2004). No significant differences were observed from the intervention (2004) to the postintervention year (2005). For the comparison schools, no significant differences were observed for either the preintervention (2003) to intervention year (2004) comparison, or the intervention (2004) to postintervention year (2005) comparison. While these observed differences are likely due in part to the new Tennessee state assessments introduced in 2004, it is also important to note that these results are suggestive of the impact of reforms in the Reading First intervention schools, including the possible positive effects of the online professional development course.

Comparison of Delivery Methods Across Characteristics of Effective Professional Development Models

The course developers identified nine characteristics of effective professional development models through a review of research studies, the conclusions of which were based on research designs that were either experimental or quasi-experimental, with a matched control group and clearly defined data measures. Although the spring 2004 administration of the reading professional development was offered only online, the same content, activities, and materials could be used to deliver the training in a face-to-face setting. With more than 40 years of experience designing and delivering professional development in a face-to-face setting, Edvantia developers are fully cognizant of the requirements and projected costs for doing so.

For the purposes of this comparison, the developer estimated that five days would be required to deliver a comparable face-to-face course. Facilitators would include one research and development specialist and one senior research and development specialist. An event of this duration would, most likely, occur when classes are out of session; otherwise, additional costs related to substitutes would be involved. An event of this duration while classes are in session would also limit the number of teachers who could attend, as few schools would release all of their K-3 teachers for the same five days. It is possible that the initial staff development could occur over a span of three days with an additional follow-up of one two-day event or two one-day events; however, the costs of supporting facilitator travel and lodging remain fairly equal for each trip, so an initial event with follow-up was not considered to be a cost-effective option.

Table 5 indicates the number of characteristics associated with the two delivery modes for the current professional development. As can be noted, the online delivery method exhibits

more components of effective professional development models as identified by research (Larson, in press) when compared to the potential face-to-face delivery of the same course; online delivery exhibits eight of the nine components and face-to-face delivery potentially exhibits 5 components.

Table 5
Effective Professional Development Components and Modes of Delivery

Professional Development Components	Online Delivery	Face-to-Face Delivery
Linked to student learning outcomes	*	*
Job embedded	*	
Ongoing and sustained with follow-up	*	
Incorporates authentic, active learning experiences	*	*
Includes subject-matter content	*	*
Encourages reflection on pedagogy, content, and beliefs	*	*
Incorporates collaboration with colleagues and/or experts	*	*
Provides support for teachers	*	
Measures impact on student achievement		

*components of effective professional development models

The components that do not exist in the face-to-face delivery option—job embedded, ongoing and sustained with follow-up, and provides support for teachers—are well-suited to the online mode. In this case, teachers did not need to leave their classrooms to participate in the online training. They could, in fact, learn and practice new skills and knowledge outside of class and return the next day to incorporate them into their teachings. This aspect of the online approach makes it highly job embedded. The course was, by its very nature, ongoing and sustained with follow-up because it was spread over a period of 16 weeks rather than isolated in five days. In addition, participants have access to the online course materials, including all content and videos, for up to a year, making it possible to have "refresher" sessions at the start-up of the following school year. Ample pedagogical and technical support were provided to teachers throughout the 16 weeks, as literacy leaders participated in a separate and private online discussion forum to share ideas and discuss methods for effectively disseminating the content. In addition, reading experts from Edvantia, the Tennessee Department of Education, and the state's reading cadre, which consists of faculty members from institutions of higher education, were also able to access the course material and communicate directly with the schools. Critical technical support was available 24/7 from Avatar, and free phone and online support were available to all participants through Edvantia tech support staff. Participants' perceived success of and appreciation for the timeliness and effectiveness of this technical support was a key finding in the previous report (Ross, Thigpin, Cavalluzzo, Guzman, & Patterson, 2004).

Summary

As noted earlier, the assessed impact of the online professional development on the schools' ability to achieve AYP is a crude indicator of the potential impact of the training on student achievement. The findings suggest a positive impact from reforms in the Reading First schools. Due to the timing of gains and of the online professional development program, it is unclear whether any causality can be attributed to those observed gains.

Based on a comparison of the nine characteristics of this training with those deemed effective through a review of rigorous research on professional development, the online delivery method exhibits eight of these characteristics. Face-to-face delivery exhibits only five.

The Cost of the Online Education Program

In this section the costs of the online professional development program are analyzed from the perspectives of the developer and provider, the state, and the schools. Those costs are then compared to the sale or purchase of the course in a face-to-face environment.

The Full Cost of Developing and Providing the Online Curriculum to Program Participants

In its first year, the online professional development program was completed by 893 teachers in 56 schools. The costs to develop and deliver the course are of two main types: fixed costs and variable costs. Fixed costs are those expenses that do not change with the amount of services provided (course seats in this case). Variable costs, in contrast, increase as more course seats are provided. It is common in the provision of online education to have a cost structure in which fixed costs are substantial and variable costs are negligible. As a result, it is cost effective to offer courses online only when large numbers of students are expected to use the courseware. Researchers obtained cost data for development and delivery of the online course from Edvantia and, based on additional discussions to clarify their purposes, allocated expenditures to fixed and variable costs. Table 6 displays the fixed costs associated with provision of the online course.

Table 6
Fixed Cost of Development and Delivery

Cost Component	Estimated Fixed Costs
Development	$59,711
Delivery	
Workshop	$1,532
Platform service fee	$3,000
Total fixed costs	$62,243
Average fixed cost per participant for 896 course seats	$72

Courseware development is the greatest source of fixed costs. The course provider spent $59,711 to develop the courseware. Costs for development include salaries for content experts, instructional designers, and multimedia developers who developed all graphic, video, and Web elements; all materials and supplies, including any software or hardware required during development; and indirect costs associated with facilities operation. The developer states that development costs would be similar, whatever delivery method is selected.

Delivering the course also involves costs that are largely fixed in nature. To deliver the course, the provider contracts with a platform provider, Avatar, to make the courseware accessible to students. The platform provider charges an annual flat fee of $3,000 for an unlimited level of use, plus $10 per course seat. The platform expense, then, has both fixed and variable components. Another fixed expense for this one administration of the course came from

a three-hour workshop that was offered to all 56 literacy leaders. Because this expense was driven by the cost of the facility and the instructor's time and travel expense, it would have been no different if fewer literacy leaders had enrolled in the course.[2] The cost of the three-hour workshop was $1,532. In total, these expenses sum to $67,243, or $71.70 per course seat, when averaged across the 896 participants who completed the course.[3]

When considering variable costs, it has been mentioned that the platform provider charges $10 per course seat to provide access to the courseware via the Internet. In addition, each literacy leader receives training materials valued at $30 each. Rather than increasing with each additional course seat, this expense increases with each additional *school* that enrolls. Table 7 displays variable costs under the assumption that, on average, 16 participants enroll from each school.

A final variable cost comes from the personnel who support the program. These people handle administrative functions such as enrollments and record keeping. They also support course participants, primarily by answering questions and solving technical problems as they arise. These expenses sum to $3,340 for salaries and indirect costs and are not expected to differ substantially over wide ranges of enrollments. This expense is thought to be rather insensitive to the number of participants who enroll. We have assumed that this expense increases 30% for each 100% increase in enrollment. Totaled across expense categories, we find that variable costs for the program were $13,980 for 896 participants from 56 schools, and those costs would rise to $25,622 if the number of schools and participants doubled. Because the cost of administrative support does not rise as quickly as enrollments, the variable cost per participant drops somewhat, from $15.60 per course seat to $14.30 per course seat, if enrollment doubles.

Table 7
Variable Costs for Providing Training for Three Levels of Enrollment

Variables	Enrollment Level 1	Enrollment Level 2	Enrollment Level 3
Number of schools	56	112	224
Number of course seats*	896	1,792	3,584
Variable costs			
Course seats	$8,960	$17,920	$35,840
Training materials	$1,680	$3,360	$6,720
Salaries and indirects**	$3,340	$4,342	$5,645
Total variable costs	$13,980	$25,622	$48,205
Average variable costs	$15.60	$14.30	$13.45

[2] Although a larger number of literacy leaders might have led to the offering of a second 3-hour session, we do not deal with that complication because, in fact, the developer has dispensed with the literacy leader workshop. Thus, it was a one-time expense associated with the piloting of the course.

[3] In fact 893 participants completed the course, or 15.95 participants per school. To simplify discussion, we round usage to 896 in our analyses, or 16.0 participants per school. The change has no meaningful impact on the cost analysis.

* Assumes 16 participants per school on average
* *Estimate assumes a 30% increase in support costs associated with a 100% increase in course enrollments

   Summing fixed and variable costs produces the full cost to the provider of developing and delivering the online course. These costs are shown for three different enrollment levels in

Table 8
Actual and Projected Cost of Online Course Development and Delivery by Enrollment

Costs	For 896 Participants	For 1,792 Participant	For 3,584 Participant
Total fixed cost	$64,243	$64,243	$64,243
Total variable cost	$13,980	$25,622	$48,205
Total cost	$78,223	$89,865	$112,448
Cost per seat	$87.30	$50.15	$31.38

   The full cost per course seat is $87.31 for 896 participants, $50.15 for 1,792 participants and $31.38 per seat for 3,584 participants. Those costs would drop if enrollments increase.

Costs Incurred by the Education System

   Each participant course seat was sold for $25, i.e., $22,400 for 896 participants. In addition, in this pilot project, the state of Tennessee subsidized development of the courseware, paying $56,000 of those initial expenses for total out-of-pocket expenses of $78,400, or $87.50 per participant. Doubling enrollments would double the payments for course seats but would have no effect on development costs. As a result, full costs per seat for 1,792 seats would drop to $56.25 per participant.[4]

Costs of Face-to-Face Delivery

   The developer estimates that an alternative, five-day, face-to-face course could be delivered at a projected cost of $7,009 per event. This cost assumes only fully-loaded staff salaries and travel expenses and is based on one research and development specialist and one senior research and development specialist serving as facilitators. The number of participants per school and the number of schools that participate in each event affect average costs. If the course could be taught in an auditorium that accommodes 100 participants, the projected delivery costs would be $70 per person. Using the average number of 16 teachers per school, the projected cost to a single school for a face-to-face setting of the course would be approximately $438 per

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[4] These figures exclude costs, if any, that schools might incur for (1) ensuring presence of adequate and reliable technology to use the program effectively, (2) participant/Literacy Leader stipends and/or costs realized or implied by the time teachers divert from other responsibilities to professional development, and (3) Literacy Leader travel for the initial workshop/training meeting. Cost categories (2) and (3) presumably would be incurred also in face-to-face delivery. Basic training in the use of the technology was provided by Edvantia.

person. In both cases, there are the costs that the system would incur if they suspended online delivery and switched to a face-to-face delivery mode. In order to compare the full cost of delivery of face-to-face instruction with online instruction, development costs must be added to these figures to obtain the full projected cost per course seat for face-to-face instruction. Because development costs per seat fall as the number of seats increases, an assumption about the level of course enrollment must be made to complete the cost analysis. Assuming that course development costs for face-to-face delivery are equivalent to online course development ($59,711), and that 896 participants receive instruction in nine groups ($7,009 x 9 = $63,081), the full cost per course seat would be projected to be $137. However, such class sizes may be unrealistic, owing to traveling distances required to amass willing groups of 100 participants. Reducing the assumed class size to 50 participants doubles delivery costs but leaves development costs unchanged, for projected costs per course seat of $207. If the face-to-face course were offered to individual schools, the projected cost per seat for 896 course seats (maintaining the enrollment rate of 16 seats per school) would be $505, or $8,075 per school.

Summary

The analysis clearly shows that the online professional development course is inexpensive and, when compared to projected costs of face-to-face delivery, cost effective. Furthermore, as the number of teachers enrolled in the training increases in coming years, the online professional development cost per participant will continue to decrease.

<center>**Conclusion**</center>

This paper examined the effectiveness of the Tennessee online professional development training on three levels: (1) impact on teacher knowledge, (2) impact on student achievement, and (3) cost effectiveness of course development and delivery.

Success of Online Course

Impact on teacher knowledge. The analyses suggest that the course itself had a positive influence on teacher knowledge. Based on a pre- and posttest comparison, teachers' awareness and knowledge clearly increased by a substantial amount (1.6 standard units) following participation in the course.

Impact on student achievement. Understanding the potential impact of professional development training on student achievement is a crucial indicator of a professional development course's overall effectiveness. Unfortunately, due to the timing of the release of Tennessee's 2005 achievement test scores, the researchers were unable to assess at the time of this report, except in a most limited way, the impact of training on student achievement. The analysis of 2003-2005 AYP data suggests that the reforms implemented in Reading First schools may have been associated with improved student outcomes. Due to the timing of gains in relation to the online intervention, and given that other efforts to improve student achievement were being implemented in these schools, it is unlikely that the online course had an important influence on those gains.

Cost effectiveness of course development and delivery. The analyses suggest that, particularly in comparison to projected face-to-face training costs, the Tennessee online professional development training is highly cost effective. Furthermore, future training and development costs will decrease as the number of participants continues to increase.

Directions for Future Research

Due to restricted access to data on instructional practices in reading and the lack of availability of public data on state reading tests for 2005, it was not possible to conduct a complete analysis of the full impact of the online reading program developed by the Appalachia Educational Laboratory for Tennessee. The knowledge base would increase if future research could measure the impact of training on classroom practices and student learning outcomes in an experimental study. To accomplish this, all stakeholders and participants must agree at the outset as to the identification of and subsequent access to data sources. Risks and benefits of the research must be known and agreed on by all parties.

This online professional development project was developed in agreement with the state prior to the consideration of completing the cost effectiveness study; therefore, access to classroom-level data was not originally sought or granted. Those data were not made available for this study. When researchers intend to collect and report data at the classroom level, the highly sensitive nature of those data necessitates the involvement of a range of stakeholders to approve its use. Increasing the number of stakeholder groups that are involved in data collection

and reporting increases the chance for roadblocks to occur. Future studies in school settings should heed this lesson and take steps to ensure full access to necessary data prior to development and implementation.

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Appendix

Table 9

Research Studies (N= 21) Meeting Selection Criteria for Literature Review

Research Study Title	Experimental Study	Quasi-experimental Study	References [Primary reference listed first]
All Learn Mathematics (ALM)		*	*University of Illinois at Chicago, 2000; Killion, 2002a*
Assessing One and All (AOA) *(learning assessment literacy)*		*	*Huai, Braden, White, & Elliott, 2003*
Cognitively Guided Instruction (CGI) *(mathematics)*	*		*Carpenter, Fennema, Peterson, Chaing, & Loef, 1989; Killion, 2002a*
Collaborative Strategic Reading (CSR)		*	*Klinger, Vaughn, Arguelles, Hughes, & Leftwich, 2004*
Early Literacy and Learning Model (ELLM)		*	*Wehry, 2001; Killion, 2002a*
Eisenhower Professional Development Program *(longitudinal study of funded professional development)*		*	*U.S. Department of Education, 2000*
Hawaii Algebra Learning Project (HALP)		*	*Young, Dougherty, Lai, & Matsumoto, 1998; Killion, 1999*
Healthy Challenges Project (HCP) *(tobacco use prevention)*		*	*Hendrix, Gilbert, Kozlowski, Bradley, & Valois, 2002*
High School Algebra Initiative		*	*Killion, 2002b*
Hull Dissertation Study *(online discourse analysis)*	*		*Hull, 2003*
Iowa Chautauqua Program *(science)*		*	*Blunck & Yager, 1996; Killion, 1999, 2002a, 2002b*
Kellogg Dissertation Study *(online course support)*	*		*Kellogg, 2003*
Mathematics Reform in California		*	*Cohen & Hill, 1998*
Mathematics Renaissance		*	*Acquarelli & Mumme, 1996; Killion, 1999*
Peoria Urban Mathematics Plan (PUMP) for Algebra		*	*Thornton, Langrall, Jones, & Swafford, 2001; Killion, 1999*
Project Creating Independence through Student-owned Strategies (CRISS) *(learning strategies)*	*		*Santa, 2004; Killion, 1999, 2002a, 2002b*
Project Law-related Education: Goals for American Leadership (LEGAL)	*		*Carroll, 1982; Killion, 1999*
Science Education Enhancing the Development of Skills (SEEDS)		*	*Killion, 1999*
Strickland Study on LISTSERVs to Sustain Staff Development	*		*Strickland, 2003*
Student Team Literature (STL)	*		*MacIver, Plank, & Balfanz, 1997; Killion, 1999*
Student Watershed Research Project (SWRP)		*	*Killion, 1999*
Total of Each Type of Study	7	14	