Using Literacy Integration to Communicate Scientifically (ULINCS)

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Abstract

The ULINCS Project research describes how elementary teachers learned a model for integrating skills of mathematics, reading, and writing with the teaching of science which led to increased teaching skills and enhanced student achievement. This joint university and school district project was funded by an Eisenhower Grant, and focused on educators working in teams to synthesize curriculum standards while planning and teaching an integrated unit. The evidence indicates that when two or more teachers at a grade level were involved in the ULINCS Project, student achievement across the grade level improved. These experienced elementary teacher participants attained a personal level of self-efficacy, and adopted dispositions that allowed them to work at a comfortable pace when dealing with district and statewide changes. Although all schools and classes in the district evidenced achievement gains, the students in classes taught by the ULINCS teachers evidenced greater gains. The research results document increases in student achievement as well as teachers' personal development.

Not surprisingly, there is a direct link between teacher thinking and student performance. The "invisible" thinking skills of teachers help generate new possibilities and increase instructional flexibility. When given a sustained professional development opportunity that challenges their content knowledge and pedagogical thinking, teachers may develop an increased capacity which leads to a high level of professional efficacy.

Introduction

Student achievement in literacy is currently a national concern in many countries, including the United States. The No Child Left Behind legislation, which was intended to be a help and support to schools, has had many unforeseen consequences, including a troubling disconnect between research on effective reading instruction, and what is actually happening in schools as described by Allington (2007). Important decisions about schools and student performance is often based on a single standardized test score, even when the stronger position is that that multiple measures more accurately determine student ability (McCabe, 2003.) A consequence of this decision making process has often resulted in the elimination of rich content learning, such as science, due to the demands of time and energy on the part of classroom teachers.

Do the time and energy for literacy and mathematics which go into test preparation really improve test scores on district and state tests, especially when it takes the place of science content learning? This haunting question has perplexed teachers and administrators alike.

A broader more comprehensive view of teaching harkens back to the ancient teachings of Pythagoras, who viewed content areas as unified. In practice, this translated into the one-teacher

classroom where a "theme unit" was often presented. Teachers diligently collected every curricular material possible on favored subjects such as butterflies or apples. They felt that by using a designated theme across different subject areas such as math, reading, and science, they were integrating the subject matter. This pedagogy held sway for some time.

Experienced elementary teachers may have already reached a personal level of self-efficacy; that is, they have adopted attitudes that allow them to work at a comfortable pace, when dealing with district and statewide change without too much internal turmoil. However, there is a direct link between the types and qualities of teacher thinking and student outcomes. A focus on these 'invisible' skills of teachers helps generate new possibilities, increase instructional flexibility and focus on outcomes, not problems according to Costas and Garmston (1994). When given a sustained professional development opportunity that challenges their content knowledge and their pedagogical philosophy, teachers may develop an increased capacity that can lead to a higher level of professional efficacy.

With this perspective, educators from Adams School District Twelve, located in the Metropolitan Denver area, and the University of Northern Colorado, met to see if teachers could support students in expanding their knowledge of science, and at the same time improve and extend their skills in mathematics, reading and writing. The two year project, Using Literacy INtegration for Communicating Scientifically (ULINCS), was born out a need to find out if integrated content learning would improve students' performance in literacy, mathematics, and science.

One of the first challenges occurred when teachers recognized that content standards within one discipline, let alone across disciplines, could not realistically be taught as separate units. Teachers who were interested in gaining content knowledge, developing integrated units in science, and improving the literacy and numeracy skills of students volunteered for the project.

Staff development for the teacher participants was initiated with a summer institute in 2000, which focused on electricity and magnetism, measurement, food and nutrition, water, human body, landforms, Colorado wildlife, and plus companion software. Teachers were assessed using pre and post science content and pedagogy tests. The following academic year involved four continuing sessions and a final summer seminar during which teachers presented their integrated science units based on a synthesized standard.

Mathematics and technology were also areas targeted for integration with science. Data from the fifth grade Colorado Student Achievement Program (CSAP) and Adams Twelve District Level Mathematics Tests were used to assess achievement in mathematics.

Method

The goal of the ULINCS project was to make explicit the linkages between science and language arts standards while embedding mathematics connections. National, state and district content standards underpinned this project. The major innovation of this project was to demonstrate how discrete content standards for science, language arts and mathematics could be combined into a synthesized standard which would serve as the basis for curricular units integrating mathematics and language arts within the context of elementary school science. This two-year professional development project provided a model for integrating content area literacy skills of mathematics, reading, writing, and oral communication with the teaching of science. Mathematics is the communication tool for science and its processes. This includes proportional reasoning, critical thinking and problem solving, all of which are essential to achieve conceptual understanding of scientific ideas.

The Participants.

Thirty teachers from 10 elementary schools in grades 3-6 began the project, and 26 completed the project. The ULINCS project began with a week-long workshop during the summer, and was followed by four Saturday morning workshops, classroom observations by project staff and e-mail journaling throughout the academic school year. During this time, teachers finished the writing and implementation of their integrated science units.

The following methodology guided the study.

The Question. Can elementary classroom teachers teach an integrated, inquiry-based science unit while simultaneously improving achievement in both science and literacy?

The Hypothesis. If an elementary class is engaged in an integrated, inquiry-based science unit, achievement in science will increase and achievement in reading will increase as measured by District Level Tests and CSAP Reading scores. In fifth grade (the only grade with a Mathematics CSAP), mathematics achievement will improve.

The Procedure.

As part of ULINCS, teachers were asked to accomplish the following:

Participate in a one week workshop in June of 2000 to receive professional development in the following areas:

- science content
- science pedagogy best practices,
- content area reading strategies,
- mathematics content,
- mathematics pedagogy best practices,
- integration of technology in instruction,
- writing a synthesized standard, and
- the design and implementation of a conceptually-based, integrated science and literacy unit.

Participate in four, one-half day Saturday workshops to continue their professional development in:

- the topics covered in the weeklong workshop,
- implementing units, and
- reflecting on instruction.

Experience at least one classroom visit by the district ULINCS Staff that involved one or all of the following:

- ULINCS teacher and district staff co-teaching,
- Observation of ULINCS teacher by district staff, and
- Observing a "model" lesson taught by district staff.

Participate in a three day, June, 2001, workshop to do the following:

- Complete ULINCS Unit Folio for teacher evaluation,
- Present Folio to other ULINCS teachers,
- Plan for future, and
- Celebrate successes.

The Observation.

The goals of professional development are to allow elementary teachers to develop a profound understanding of the content they must teach and to be more effective in terms of their pedagogical skills and instructional strategies, to build their ability to communicate with colleagues and to encourage personal reflection on professional growth so that they might better serve as mentors and models to others. Professional development extends elementary teachers' visions of whom they are and what they can do; it broadens their horizons as educators and empowers them as agents of change in the broader scope of the educational enterprise. Instead of

feeling isolated, teachers who participate in professional development programs, such as ULINCS, and to become members of a larger sustained community of educators.

At the initial summer session and during the Saturday workshops, participants were given explanations and written examples about synthesizing content standards. Some found these relatively easy to write, while others were bogged down by the wording, thinking it was dense and ponderous even when wording was taken directly from the Standards (NCTM, 1989; NCR,1995). By the following summer, teachers were ready to present synthesized standards for their integrated units, to share student work sample, and to discuss their professional development reflections.

Qualitative results

While planning and writing their integrated science units, the ULINCS teachers volunteered comments from their reflective journals. Qualitative data illustrate how the teachers and students benefited from content integration as an aide to communicating scientific ideas.

The ULINCS teachers reported that they saw:

- hard-working educators attempting to increase their knowledge and skills to teach children;
- excellent presentations and ideas to integrate mathematics, language arts and technology into elementary school science;
- educators actively engaged in learning science;
- a close and supportive connection between their school district and the university,
- lots of great ideas being implemented;
- people talking and interacting about subject matter;
- educators developing profound understanding of fundamental mathematics and science concepts;
- elementary school teachers making connections across content areas;
- good teaching practices being modeled; and
- many helpful teaching strategies that could actually be used.

The ULINCS teachers reported that they experienced:

- hands-on measurement laboratory centers;
- lots of hands-on science investigations;
- writing in the context of mathematics and science;
- integrating language arts and mathematics into elementary school science;
- new things on the computer they had never done before; and
- lots of thinking and planning.

The ULINCS teachers reported that they heard:

- good discussions about many topics;
- new ways to teach and do things; and
- strong science and mathematics language use.

Teacher reflections from the initial summer ULINCS workshop show an increased interest in promoting inquiry-driven instruction.

- *I like the concept of inquiry based teaching…but putting it into action is the challenging part.*
- *I learned more about inquiry based teaching and learning. We were given a lot of interesting ways to pose questions.*
- *I have realized that there are two forms of thinking I must follow. Think as the teacher to anticipate questions and ensure students understand the concept. Prior to answering these questions, you should put yourself into their shoes to see if the lesson makes sense or if it has any gaps."*
- *Inquiry: How else could I look at it differently? Promote healthy skepticism.*
- *I will concentrate more on content. I wonder if I didn't go into depth enough with the students. What is too much for them?*

Quantitative results

Teacher Gains

Quantitative pedagogical and content assessments were developed by the ULINCS staff, and were administered at the beginning and end of the initial summer workshop. The assessments were scored by the ULINCS staff, and the data were analyzed by the external evaluator. Six open-ended knowledge/skills questions were administered, in addition to a 10-item Likert scale teacher self-assessment of proficiency in pedagogical knowledge and skills scored using a 0 to 4 rubric. Repeated measures statistical analysis revealed a statistically significant increase of 60.9% from pre- to post-test.

Table 1: Descriptive Statistics

Time	N	Mean	St. Dev.	% Increase	t	P pretest
pre test	26	11.42	6.15			
posttest	26	18.38	2.08	60.9%	6.03	.0000

The ULINCS teachers gained knowledge in each of the following elementary school science subject areas: electricity and magnetism, measurement, food and nutrition, water, human body, landforms, and Colorado wildlife. Each subject area group contained two to five members, according to the grade-level science standard addressed. Moreover, all ULINCS teachers were given a pre- and post workshop assessment of their knowledge of metric measurement concepts. This test had a possible score of 21 points. The pre-test showed a group mean of 9.68 points with a 2.79 point standard deviation; the post-test group mean was 14.08 points with a 2.10 point standard deviation. The data reflects a 45.4% gain score for these mathematical concepts.

Student Achievement.

A second-strata goal of the ULINCS project was to significantly improve student achievement in the areas of science, language arts and mathematics as measured by standards-based assessments. Adams 12 District Grade Level Achievement Tests showed improvement in mathematics, reading, and science. Colorado Student Achievement Program (CSAP) test scores were raised in mathematics and reading; science was not tested until grade 8. Six of the eight schools showed increased achievement in reading. In all ULINCS fifth grade classrooms and schools, the teachers reported emphasizing the improvement of mathematics skills through science because of low CSAP mathematics scores in previous years. Many more mathematics integration pieces were added to two fifth grade science units, Magnetism/Electricity and Food/Nutrition, than in grades three and four. These observations suggest that the teachers' understanding of how mathematics is used in the context of science supported increased emphasis on integrating mathematics.

The data from this study demonstrates that a cognitive shift needs to take place. When teachers look at the standards, even within one discipline, let alone across disciplines, they recognize that they cannot teach them all as separate units. They begin to see that there is common ground among the standards and that there are similarities in the objectives and goals across the standards. Today teachers are challenged to produce a different type of integrated unit. They must switch to a new conceptual basis by beginning a unit, not with a topic, but with specific content standards, and by ending with a synthesis of these standards.

The project team concluded that ULINCS accomplished many of the vital signs for effective group professional development. One of the most telling improvements made by the ULINCS teachers was in their ability to acknowledge and change their approach to choosing and synchronizing strategies to enhance the integration of science, mathematics and literacy. In their own words the teacher participants commented about their intentional use of strategies:

> When we choose strategies to teach the science concepts, we need to know our own students' background, abilities, knowledge and behavior.
>
> Branching out to try new strategies is so important.
>
> A difficult part to integrating is to figure out …which skills should be taught prior to which one.
>
> It was so valuable to do some hard thinking about how it is we go about choosing the strategies when we teach kids to navigate the wonderful world of learning. I often let myself rely on the tried and true techniques I'm comfortable with when I should be stretching beyond.
>
> I do know that I have a variety of strategies to choose from. I surely need to look and think more clearly about what I want the kids to come away with.
>
> When we use a particular strategy, explain it to the students and tell them what you are doing and what it is called.
>
> An eye-opener: using student reading log for speaking and listening at least once a week. I will need to model this with something I am reading.

There was a concern that some teachers worry about the name they call a literacy, science or mathematical strategy. They felt that a different name might confuse the students the next year. One teacher reported "that some students might be irreparably damaged if next year's teacher call strategy "x" strategy "y." However, she countered that the point of teaching a heuristic strategy is to help students make meaning. "The strategy is a tool - not the point of learning."

> Another teacher wrote the following in her reflective journal.
>
> A strategist is a problem solver who has some systematic way of going about things… the strategy is an artificial scaffold to help access material that would otherwise be inaccessible.

It is assumed that at some point the scaffolding can be removed and the brain will process the text efficiently, and thus allow for making meaning. Further educational research is needed on what students are thinking at a metacognitive level when they process and translate a heuristic mathematical or literacy strategy within a science lesson.

The Synthesis of Standards

What is unique about ULINCS Units is that the teachers developed the writing and application of synthesized standards. These teacher participants were given explanations and written examples of how to synthesize content standards. They began with the district's version of discrete state model standards and objectives. A sample comparison of a language arts standard with objectives to a science standard with objectives reveals similarities in the learning processes described for both language arts and science. Upon further analysis, it was determined that the language arts objectives (in this case, reading objectives) could serve as a tool to access the more specific learnings within the science objectives, which is more content laden.

Mathematics was also determined to be a process which could access the content knowledge contained in Science. It may also be noted that the standards with objectives for language arts, science and mathematics generally have a common denominator: problem solving.

Table 2

A Comparison of Language Arts/Reading Standards/Objectives to Science Standards/Objectives

Language Arts Standard – Reads to Understand a Variety of Materials	Science Standard – Conducts Investigations
Objective 1: Understands a variety of narrative and expository texts at literal, interpretive and critical levels.	Objective 1: Reads information to plan and conduct scientific investigations that include asking questions
Objective 2: Increase vocabulary	Objective 2: Explain and observe change in a system using words, diagrams and graphs

The following is a narrative example of how teachers chose to write a synthesis of these two standards for their integrated unit activity. Concepts from mathematical standards are also embedded in the description.

Synthesized Standard for "Were You Aware" Activity

> First, the students predict and make a graph using the percentages of the types of water found on earth. Then the students read a science story to confirm and adjust their predictions. For this, they set a purpose for reading, then read for understanding. Using their new learning, they re-evaluate and adjust the graph. Finally they share their learning and knowledge by writing sentences about the interpretation of the graph, using vocabulary that is mathematically and scientifically accurate.

In comparing the two ways to write standards, one can see that synthesis requires the capacity to incorporate content from reading, writing, math and science. The process goes beyond curriculum integration and requires a higher level of conceptualization by the teacher to maximize student learning. Teachers must think about instruction as a unified process.

The process of synthesizing standards and objectives is revolutionary because, without it, the planning for teaching events and learning typically falls back into the traditional format of teaching separate subject areas. Learning becomes fragmented, and teachers do not have enough time to teach all the discrete standards and content areas, given the time constraints. The end result is that critical content areas, such as science, are omitted from the taught curriculum. This is a deplorable situation, because the knowledge and learning from this rich content area may be lost to our elementary school students. The net effect is that students go on to middle and high schools with a paucity of knowledge in science. The positive effect of the synthesized standards is that science can be effectively taught using language arts and mathematics, and that students benefit greatly from this new way of thinking.

The ULINCS integrated science and literacy approach is based on the belief that young children, like adults, need a purpose to read, to write, to speak, to listen, and to apply mathematics. Inquiry science units build common experiences upon which to apply their literacy skills.

Student Achievement

The Teachers/Schools: The self-selected ULINCS teachers represented ten different elementary schools. Data are reported for only seven of the schools because three of the schools had only one teacher at a single grade level. Of the seven ULINCS schools with teacher teams, one was a low performing Title I school with a low socio-economic scale index, and three of the schools had significant numbers of at-risk students with one school having close to 50% at-risk

student population. One school was a special education center school and two other schools reported having more than 10% special education students.

Two schools reported 10% or more gifted and talented students with one school reporting 13% gifted and talented students. Two schools reported having a population including 2% English Language Learners.

How the Data was Reported.

All ULINCS teachers gave the Northwest Evaluation Association (NWEA) Science Concepts and Processes Level Tests for both Fall 2000 and Spring 2001. However, the data could only be used from seventeen teachers due to problems with scoring the Level Tests and the number of students who were not able to be retested in the Spring. All teacher participants who had complete data for Fall 2000 and Spring 2001 NWEA Level Tests had their data reported in the results. Only the data from the ULINCS teacher participants' classes are reported for science since their non-ULINCS colleagues were not required to administer the NWEA Science Level Tests.

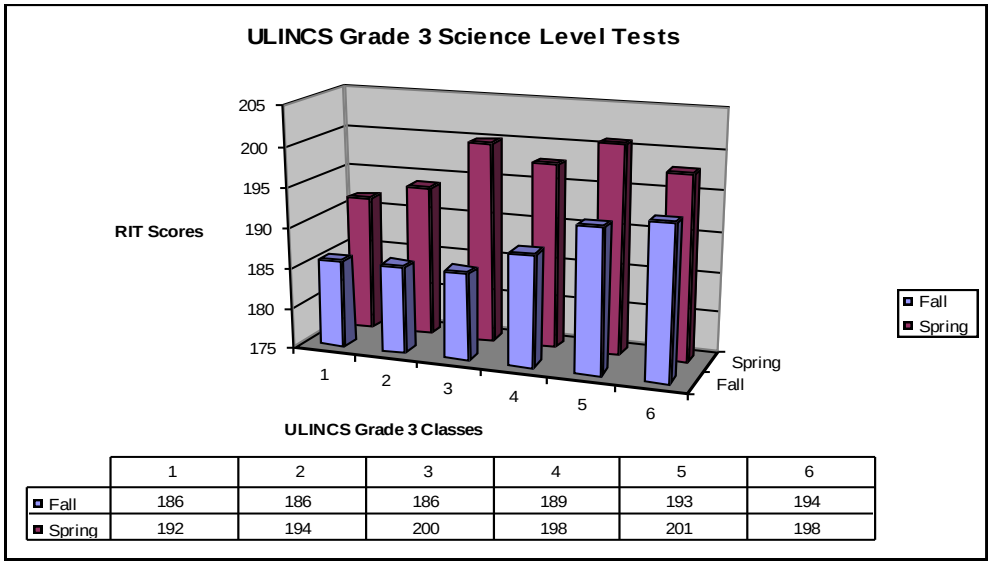
Data from the Colorado State Assessment Program (CSAP) for reading and math represent all the students at grade level in a ULINCS school; this includes both ULINCS and non-ULINCS teachers at that grade level. In addition, only grade levels with two or more ULINCS teachers were reported. Since all schools were required by the state or the district to report scores in reading and mathematics, these data were accessible for this study. The (CSAP) included the areas of mathematics and reading for the 2000-2001 academic year. The results represent the percentage of students who were designated proficient or advanced on both the CSAP Reading and Mathematics Assessments for their specific school and grade level.

Science, which was not assessed at the elementary level by the CSAP, was assessed by the NWEA Levels Test using RIT scores. The RIT scale score indicates a student's current instructional level along the curriculum scale and can be used to measure growth within a specific school discipline, e.g., science, reading, writing, etc. RIT scores are a continuous scale and can be compared to height being measured in inches. If a student has a 190 science RIT score in the Fall and a 194 science RIT score in the Spring, the student shows a change of 4 RIT scale points which is equivalent to one year's growth in the area of science.

The Results for Grade 3.

The graph in Figure 1 shows the results of all of the ULINCS third grade teachers' students for Fall and Spring on the NWEA Science Concepts and Processes Level Tests. This test measures students' abilities to understand key science concepts related to cause-effect, cycle, force, interaction, model, scale, systems, and theories. It also assesses the science thinking processes of classifying, interpreting data, inferring, measuring, observing, questioning, and designing experiments.

Figure 1



	1	2	3	4	5	6
Fall	186	186	186	189	193	194
Spring	192	194	200	198	201	198

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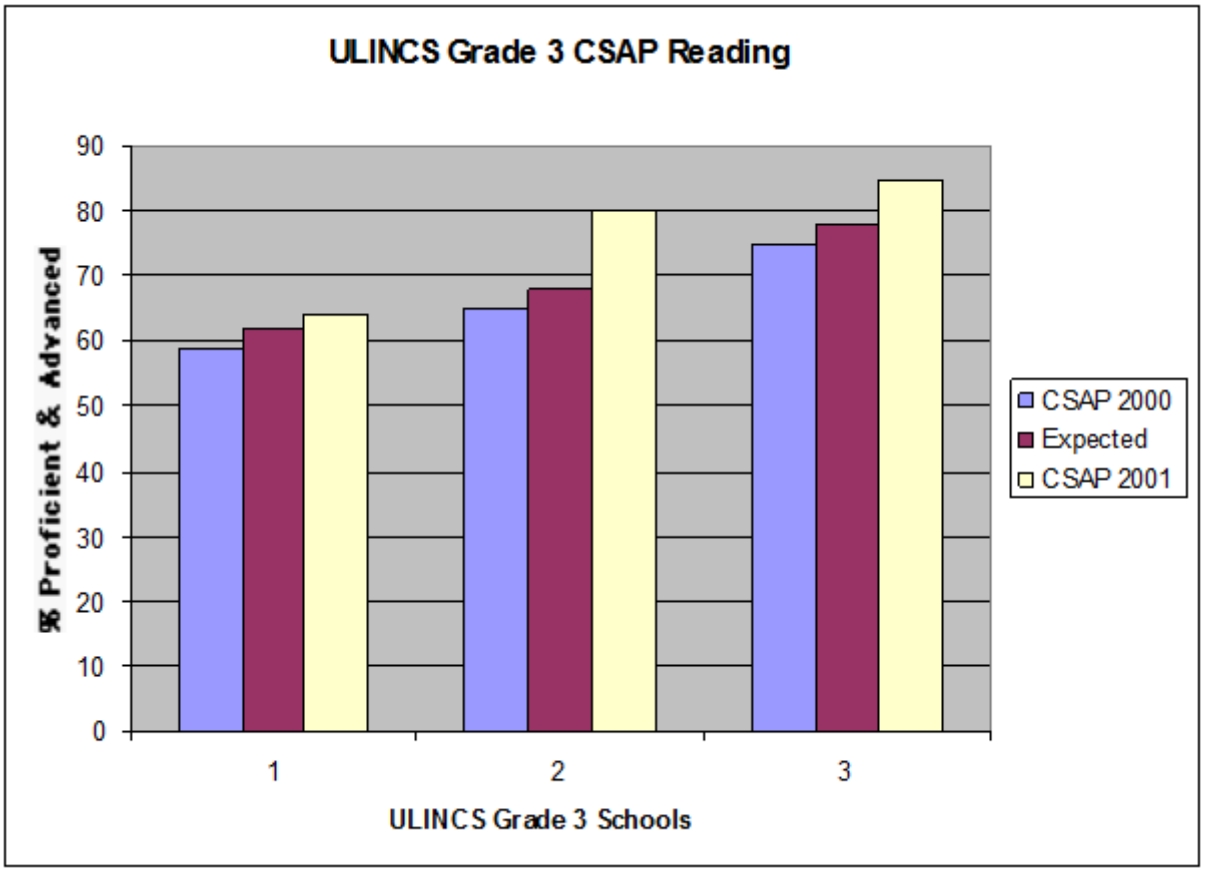
Again, on the NWEA Science Level Test, a gain of 4 RIT units is comparable to one year's growth. All six ULINCS classes demonstrated a year's growth or more. In three classes (2, 4 and 5), two years' growth were recorded. In one class (3), three years' growth was recorded.

In Figure 2, the entire third grade's Spring 2000 CSAP Reading scores (which includes non-ULINCS teachers) are compared to their Spring 2001 CSAP Reading scores. The expected score is derived from assuming that if the students remained at the same level in reading, their scores would have improved in relationship to the statewide increase of scores.

Figure 2



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The six third grade ULINCS teachers represented teams of two from three elementary schools. In all three schools, reading achievement increased. This is significant because not all the students represented by this data were from ULINCS classrooms. Some gain may be attributed to the fact that teachers plan and teach together at their grade levels, and share strategies from the ULINCS professional model. Improvement in scores may also be attributed to the adoption of a new reading series program. Results suggest that when two or more ULINCS teachers were at a grade level, achievement across the grade level increased. Although all schools and classes evidenced achievement gains, the students in classes taught by the ULINCS teachers evidenced greater gains.

The Results for Grade 4.

The graph in Figure 3 represents the results of the fourth grade ULINCS teachers who had both Fall and Spring scores for their classes on the District Science Concepts and Processes Level Tests. All five classes demonstrated at least a year's growth, a gain of 4 RIT units. In Class 2, three years' growth was reported. Two of the schools were Title I Schools and are represented as "School 1" and "School 2" in the graph.

The units selected for integrating with literacy were FOSS (Full Option Science Systems) Landforms, Measurement, Human Body, and Water, in addition to the newly developed Colorado Wildlife Unit which was developed by Linda Block-Gandy (2000).

The Colorado Wildlife Unit, although not a FOSS Unit, uses a FOSS-like format and served as the ULINCS model unit for how to integrate science and literacy. It was designed specifically for the purpose of providing ULINCS teachers with a model unite before they attempted to design their own integrated unit.

Figure 3

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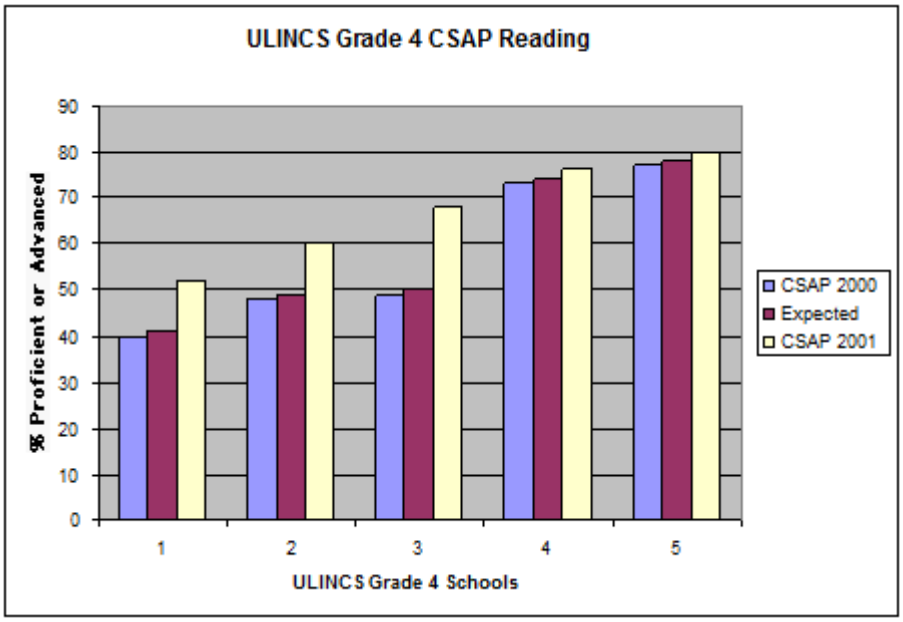


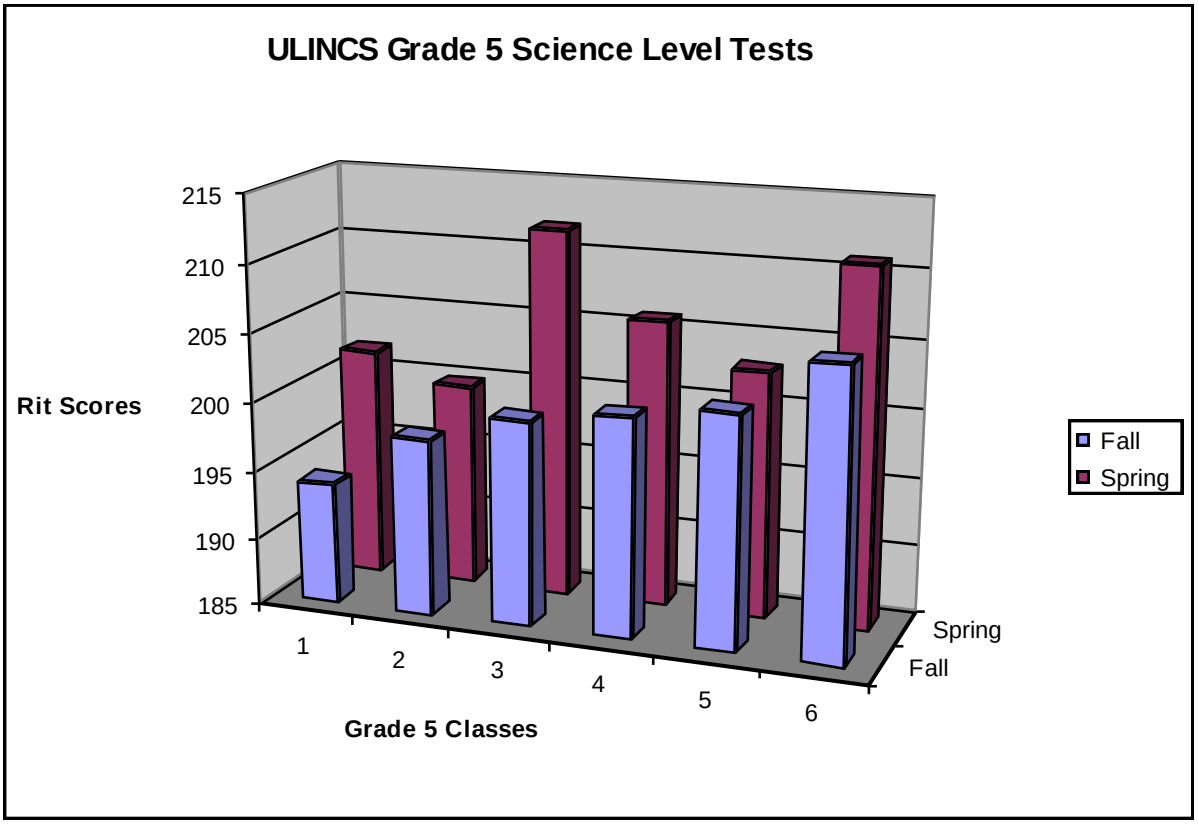
The graph in Figure 3 represents all of the student data from the fourth grade ULINCS teachers. Spring 2000 CSAP Reading scores are compared to the Spring 2001 CSAP Reading.

The expected score is derived from assuming that if the students remained at the same level in reading, their scores would have increased comparably to the increase statewide.

In all five schools, CSAP Reading achievement increased over the entire fourth grade. It should be noted that even the two schools with relatively high reading scores, scores increased over the expected, and, furthermore, significant gains were made by the lower performing district staff observed that grade level team planning was the standard in these schools.

Once again, this data represents both non-ULINCS classrooms and ULINCS classrooms. This suggests that even non-ULINCS classes benefited from the ULINCs Units.

Figure 4



The Results for Grade 5

The graph in Figure 4 shows the results of all of the fifth grade ULINCS teachers who had fall and spring scores for their classes on the Science Concepts and Processes Level Tests. Although all classes demonstrated growth, two of the classes (Classes 2 and 5) did not demonstrate a year's growth. In two classes (4 and 6), students grew 5 RIT units for a year's growth, in one class (1) students grew two years, and in a third class (3) students grew three years. The units selected for integrating with literacy were FOSS Magnetism & Electricity, and FOSS Food & Nutrition.

The six ULINCS teachers who taught fifth grade represented four different schools. Since a Spring 2000 Reading CSAP was not administered in Colorado, the Fall 2000 and Spring 2001 Reading Level Tests were used to compare growth. The Spring 2001 CSAP is also provided for comparison. School 4 did not elect to do a Spring Reading Level Test.

School 1 evidenced a year's growth in reading if one compares Fall 2000 Reading Level Tests to Spring 2001 Reading CSAP.

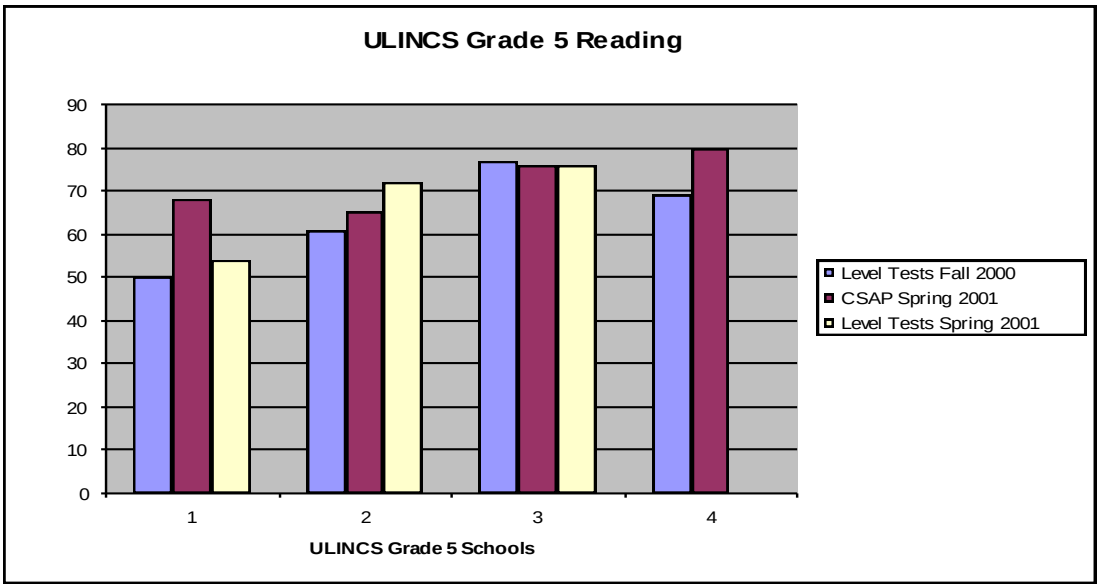
School 2 evidenced a year's growth in reading if one compares Fall 2000 Reading level Tests to Spring 2001 Reading Level Tests.

School 3 evidenced no growth in reading achievement using Reading Level Tests Comparisons or CSAP comparisons.

School 4 evidenced a year's growth in reading if one compares Fall 2000 Reading Level Tests to Spring 2001 Reading CSAP.

Thus, three of the four schools showed increased achievement in reading.

Figure 5



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In Spring 2001, the Math CSAP was administered in fifth grade and was not given in grades three and four. Since the Math CSAP was not administered in Spring of 2000, the Fall and Spring Math Level Tests were used to chart mathematics achievement. In all four schools, mathematics achievement exceeded a year's growth when using either the Fall to Spring Mathematics Level Tests comparisons or the Fall Mathematics Level Tests to Spring Math CSAP.

FOSS Science has embedded mathematics problems and emphasizes extensive use of students working with numeracy skills, geometry concepts, probability, collecting data, making graphs, and interpreting data from charts and graphs on both the District Levels Test and state CSAP. In all ULINCS fifth grade classrooms and schools, teachers reported emphasizing the improvement of mathematics skills through science because of their low Fall 1999 Math CSAP scores. Consequently, many more mathematics integration pieces were added to the fifth grade science units than in grades three and four. These observations suggest that the lower science achievement in two classes (both teachers reported focusing on mathematics) and the lack of growth in reading in a school that had higher than average reading achievement may reflect the increased emphasis in integrating mathematics over literacy. One school which had higher than

expected reading achievement (Figure 5), maintained its high achievement level in mathematics achievement.

Conclusions

Four major findings emerged the research:

1) teachers improved their science content knowledge;
2) teachers learned to choose specific pedagogical strategies, such as graphic organizers, when planning an integrated unit for mathematics, science and literacy;
3) teachers learned to compare and contrast three different content standards in order to write a synthesized standard for essential and topical questions related to their units; and
4) students improved their achievement as documented by district and statewide testing.

The results of this study strongly support the linkage between achievement in science and increased literacy and numeracy when teachers are provided the time, appropriate instruction and resources to learn the science content and pedagogical skills necessary to design and implement an integrated, inquiry-based science unit.

Given the substantial evidence in this study, we advocate that de-emphasizing or eliminating the teaching of science to provide more time for literacy blocks may not be "the best practice." Science, an inherently motivating and stimulating subject for elementary students, can be positively integrated with literacy and mathematics. In fact, the data suggests that integrating literacy and numeracy with content increases achievement in science, reading and math as documented by results on both district and state-wide assessments. It also suggests that when mathematics becomes an integral part of an integrated science unit, mathematics achievement increases.

These findings are not unique to ULINCS. Michael Klentschy (2001) reported similar achievement gains in the Valle Imperial Project in Science. In his study, FOSS and other standards-based, inquiry-driven science modules were used along with integrated literacy strategies that focused on reading and writing. His data reported gains in both reading and

writing with the gains increasing the longer the students were exposed to FOSS-like integrated literacy units.

The ULINCS Project demonstrated that:

> Sustained Professional Development in science, math and language arts lead to a community of ULINCS teachers who
>
> were able to. . .
>
> Synthesize Standards and Objectives
>
> which led to
>
> Increased achievement of students in Science, Math and Reading, as documented by district and state test data.

The ULINCS integrated science and literacy/numeracy approach is based on the belief that young children, like adults, need a purpose to read, to write, to speak, and to apply mathematics. Inquiry science units build common experiences upon which to apply their literacy skills.

Benefits from the ULINCS Project.

The overall benefits from ULINCS can be summarized in a four-parts:

For the teacher:

- Analyze the purpose, process and critical thinking skills inherent within one standard;
- Compare commonality of language and meaning of vocabulary across the standards;
- Write synthesized standards and implement the integrated unit.

For the student:

- Start with science inquiry;
- Read both fiction and non-fiction;
- Write up scientific results in a variety of ways;
- Make an oral presentation.

For the district:

- Increase standardized test score for all three disciplines;
- Create community of learners within buildings and across the district.

For the university:

- Keep theory grounded in school practice;
- Increase research-based action for in-service teachers;
- Hone university/school partnerships.

The findings of this study demonstrate that elementary teachers and students derive great benefits from including science in the curriculum when literacy and mathematics standards are synthesized within the planning process and then used as tools to access and express this content knowledge. The ULINCS project began because teachers and University faculty members were concerned about the decreased time devoted to science and the increased time spent on test preparation. What we learned from the study is that science provides a rich curriculum in and of itself, and is a tremendous avenue for advancing the learning of mathematics and literacy. These are crucial points we hope will be shared with teachers administrators, parents and legislators who believe that teaching literacy and mathematics alone will increase student achievement. As the study demonstrates, the opposite is true.

Future research will be needed to continue to understand how content standards in other content areas may be synthesized when teachers plan for learning experiences which are meaningful, holistic and doable within a challenging academic schedule. When students are motivated to learn about themselves and their world, reading, writing and math become the natural tools to help them unlock and expand this knowledge.

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