Using Literature to Learn about Math and Science in Primary Classrooms

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Studies have been conducted investigating literature, science, and math in the primary grades (e.g., Morrow, O'Connor, & Smith, 1990; Good, Grouws, Mason, Slavings, & Cramer, 1990). However, most of these studies have focused on these subject areas as discrete units rather than integrated bodies of knowledge that can be related to one's life experiences (Alvarez & Vaughn, 1992; Donham, 1949; Erickson, 1984; Eylon & Linn, 1988; Giroux & Simon, 1989; Sarason, 1990). When subject areas are treated as compartmentalized units, students often resort to memorizing these facts and ideas for later retrieval to be either asked by the teacher or performed through an examination (Whitehead, 1929; Potts, St. John, & Kirson, 1989). This type of presentation results in students mistakenly believing that success in school is equated with "knowing" a given body of knowledge of a subject rather than "learning" how this new knowledge can be related to their experiences and other subject disciplines both in-and-out-of-school (Alvarez, 1993; Alvarez, Binkley, Bivens, Highers, Poole, & Walker, 1991).

In order for novice readers to appreciate literature and subsequently develop into lifelong readers, teachers need to respect their students' current level of intelligence by allowing them to share their daily experiences with those encountered in the classroom. Often these out-of-school experiences are shunned in favor of a literacy curriculum that consists of a structured schedule of books to be read and a set of

questions to be answered. In these instances, efforts are concentrated on *analysis* (separating) of a poem or story, but not on the aspects of *synthesis*. In contrast, a classroom that is constantly providing literacy contexts that focus on the logical processes (e.g., joining, selecting, discarding, implying, and entailing) of ideas gives students a learning context that they have helped to create and are aware of for themselves (Henry, 1974). Reading demands thinking through the combining of analysis and synthesis to form conceptual development.

Efforts have been made to engage primary grade students in synthesizing literature and relating this information to their present experiences (Alvarez & Vaughn, 1992). In this theme-based integrated model, students' world experience is an important consideration as are efforts by the classroom teacher to provide literacy contexts that focus on the logical processes (e.g., joining, selecting, discarding, implying, and entailing) of ideas that gives students a learning context that they have helped to create and are aware of for themselves. These preliminary findings indicate that kindergartners can synthesize literature by discovering relations among facts and ideas, and then create a structure that incorporates these facts and ideas into extended relations by generating new stories.

This paper demonstrates how literature can be used to learn about math and science concepts in kindergarten, first, and second grade classrooms. The objectives of this paper are to : (a) demonstrate how literature can be used to learn about math and science; (b) demonstrate how analysis and synthesis of fables can lead to concept development in reading and writing; and (c) discuss how critical thinking can lead to incorporated knowledge that can be retrieved and applied to other settings. The research question that guided our action research study was "Can kindergartner's, first, and second graders be taught to incorporate literature, mathematics, and science concepts in a meaningful context?"

Method

Subjects

A total of 43 kindergarten (n = 24), first (n = 9), and second grade (n = 10) students received instruction from their regularly assigned teachers. The first and second grade students were in the same class (split first and second grade) taught by the same teacher. The study took place in March, and lasted for three weeks.

Students in kindergarten, first, and second grades used the fable *The Crow and the Pitcher* as a base from which to first analyze and then

synthesize events and characters and learn mathematic and science concepts. Like other folk narratives, fables have certain characteristics that appeal to a child's sense of imagination, feelings, and intellect. Fables tell a story that is short and to the point. By virtue of being a story a fable shares the basic components of a short story: an introduction, a body, and a conclusion. Fables have animals that speak and act like humans, and leave the reader or listener with a lesson or moral.

Kindergartners' Use of Folk Tales and Fables to Learn about Math and Science

These 24 kindergartners were the same students who participated and demonstrated their ability to analyze and synthesize folk takes earlier in the fall (see Alvarez & Vaughn, 1992). Like the previous lesson that occurred in the fall of the year with folk tales, the fable, *The Crow and the Pitcher*, was analyzed by using a visual story map. This story map included the initiating event, problem, attempts, outcomes, and moral of this fable (see Figure 1).

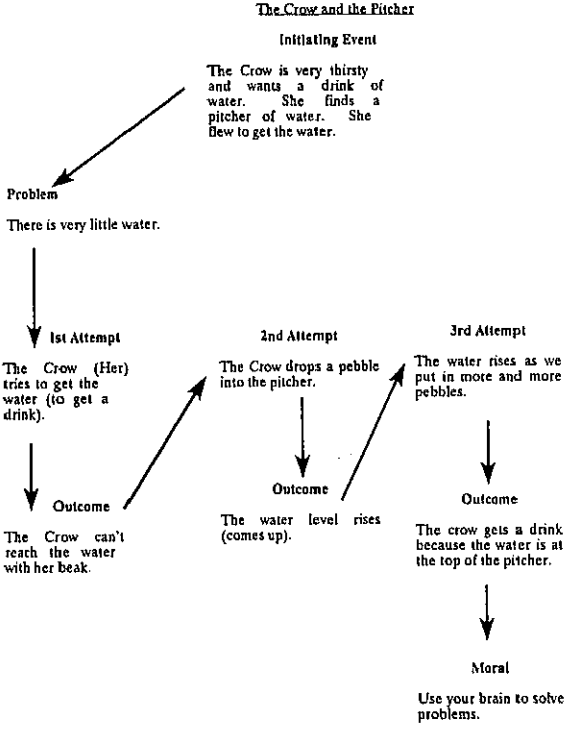

Figure 1. Story map developed by kindergartners.

The children then applied mathematical principles and scientific reasoning in problem solving formats. To illustrate, Aesop's *The Crow and the Pitcher* was read and analyzed, the students then read a compatible fable, *The City Mouse and the Country Mouse*, that had a related moral. Students synthesized the two fables pointing out likenesses and differences of the events and characters of each fable. Then they engaged in an experiment to determine how many pebbles were needed to make the water rise so that a crow could drink the water. The teacher (the third author) asked her students to predict how many pebbles it would take to make the water rise to the top. The predictions made by the students are presented in Table 1.

Table 1.

Kindergartners predictions of the number of pebbles needed to displace water.

Prediction Chart	
Student	Number of Pebbles
01	22
02	105
03	1 zillion
04	502*
05	639
06	50
07	20
08	10
09	63
10	1000
11	5
12	95
13	159
14	242
15	1 million
16	32
17	100
18	300
19	99

*Number of pebbles needed to displace water to the brim of the pitcher = 462.

Students were required to measure and mark the water level,weigh each pebble, and drop it into the pitcher. These students charted how much each pebble weighed and calculated how many pebbles were placed into the pitcher to make the water rise to the top (the concept of displacement).

First and Second Graders Learn about Math and Science

As part of a year-long discussion of the types of literature, with emphasis on fables, folk tales, legends, myths, and fairy tales, the split class consisting of first and second grade students was introduced to two versions of the fable, *The Crow and the Pitcher*, by their teacher (the second author). After reading and discussing both versions of this fable, students compared and contrasted the two discourses (analysis and synthesis). Each student also decided which version they liked best and why.

Next, the teacher and students discussed the lesson or moral of the fable and determined the statement which best encompassed the moral of the fable was "use your brain to solve problems." The students were then given another fable, *The City Mouse and the Country Mouse*, and were asked to analyze and synthesize this fable with that of *The Crow and the Pitcher*. Students then mapped a plan for writing their own individual fables using the same moral. After the students wrote their fables they shared them with the class.

A first grader's response to the "lesson" learned in the fable, *The Crow and the Pitcher*, was "Allwse think be for you do some ing." When asked to write a fable of his own about "Using your brain to solve problems" he wrote:

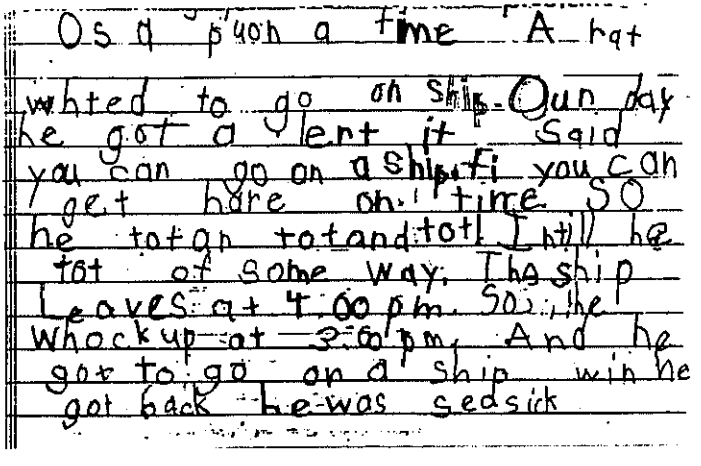
Os a pon a time A hat
whted to go on ship. Oun day
he got a ylent it said
you can go on a ship if you can
get here on time. SO
he tot an tot and tot I till he
tot of some way. The ship
Leaves at 4.00 p.m. SO the
Whock up at 2:00 pm. And he
got to go on a ship with he
got back he was sedsick

Figure 2. A fable written by a first grader.

His story reveals that the aforementioned "lesson" or moral of the fable could be applied to another setting in which a rat sets the clock at a time that will allow ample time to be on board the ship before it sails. However, sea sickness results in an unforeseen circumstance.

Ryan, a second grade writes a fable about a mouse who has to problem solve a situation that requires getting past a cat to get a piece of cheese (see Figure 3).

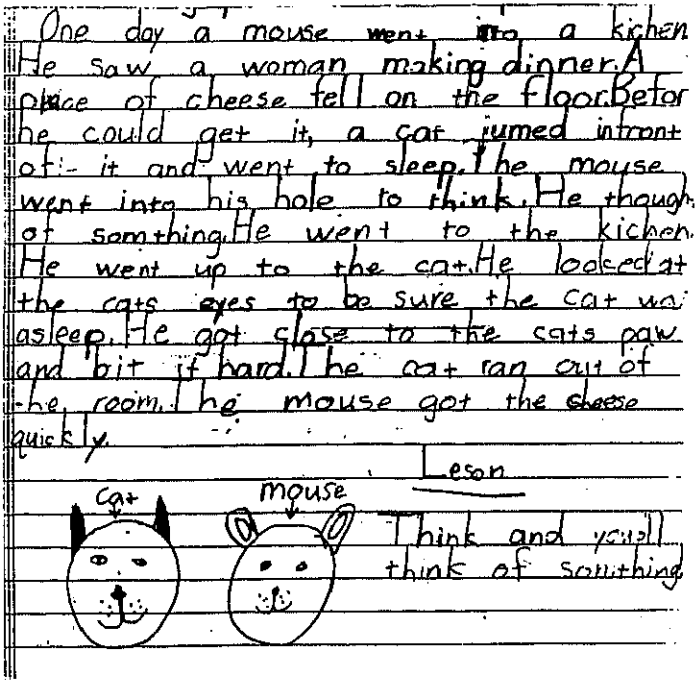

Figure 3. A second grader's fable.

The moral of his story, "Think and you'll think of something!" is a provocative statement. It alerts classmates and other readers of his fable of the need to analyze a problem situation by using one's prior knowledge, experience, and imagination for its resolution.

To integrate science and mathematics with this literature lesson using the concept of displacement, the teacher assigned students to five cooperative groups that were matched based on her judgement of their reasoning and problem solving abilities. There were four students in Groups 1, 2, and 3, and three students in Group 4. Each member of the group, with the exception of Group 4, had a leader, a recorder, a checker, and a teller/presenter. The role of the leader was that of a facilitator, the recorder noted the events that were transpiring, the

checker supervised the experiment's progress, and the teller/presenter was responsible for reporting the results of the group's investigation. Group 4 had three students who were designated as a leader, recorder, and teller/presenter. Social interactions among the group members and the teacher were ongoing.

In the first experiment, using pebbles to displace water, each student had their individual science/mathematics log prepared by the teacher that contained questions and illustrations to guide the inquiry. The apparatus consisted of a glass pitcher, pebbles, ruler, spring scale, crayon, and water. Each group had a pitcher that the teacher had pre-marked with different levels on each. The leaders filled their respective pitchers with water to the prescribed level. They used a ruler to measure the height of the water--the recorder noted it in inches in their groups science/mathematics log.

The students took turns adding pebbles to the water to bring the level to the top. The recorder kept a tally of the number of pebbles placed into the pitcher. Some groups counted the pebbles one at time, some by 2's, and some by 5's.

The students and the teacher discussed the number of pebbles each group used. They also discussed *why* the water displacement level rose when pebbles were added. Each group counted the number of pebbles it took to displace and raise the water level. Each of the five groups had a pitcher of unequal volume and an initial water level different from the others.

After displacing the water to its capacity, the students then added more pebbles to their pitchers until the water "bulged" above the top without overflowing. The teacher and the students discussed *why* the bulge occurred and how many more pebbles were used to create this state. Bulge was explained in terms of how molecules of water stick to each other, and form an "invisible skin" that hold the water together. A question arose, "What if more pebbles were added to the container?"

The students tested this question by adding more pebbles until the "skin" broke and the water overflowed and discussed *why* and how many more pebbles were used to make the phenomena occur. The number of additional pebbles needed to break the "skin" was added to their total number of pebbles. The water was poured out and the pebbles were weighed using a spring scale. Mathematical concepts of greater than and less than were evaluated and discussed as it related to each respective group's number of pebbles and weight.

The second experiment with the concept of displacement involved the use of apples. The apparatus consisted of two apples of different

sizes and shapes (a smaller red apple and a larger green apple), a glass bowl, water, and a crayon. Predictions were made by students as to which of the two apples would displace the most water. Students were then asked to submerge the red apple in a bowl of water. A mark with a crayon was made on the inside of the bowl indicating the water level. The red apple was then removed and replaced with the larger green apple. Again the students were asked to mark the water level. The second apple was then removed. Students were asked to check their predictions as a way to confirm, alter, or reject their hypotheses. The students compared the crayon marks and indicated which one was higher.

Class discussion revealed that the bigger the apple the higher the water level. Students were asked to think about why this occurs. Students then formulated a scientific explanation that stated that the bigger apple displaced more water. It pushes more water up and out of the way and takes its place. One student associated the concept of water displacement with a person getting into a bathtub and having the water level rise. Another student applied this same concept to water rising in a swimming pool when a diver plunges into the water.

Findings

The kindergartners needed 462 pebbles to displace the water in order to make it rise to the top of the pitcher. They compared this number to the prediction chart and found that the closest person had speculated that it would take 402 pebbles to displace the water. The students then emptied the water from the pitcher, removed the pebbles, and began counting and sorting them by 10s.

The first and second graders' experiments are represented in Table 2. The number and weight of each group's pebbles varied depending on the level of water at the outset and the number of pebbles needed to displace the water to break the "invisible skin."

Table 2.

Grade, gender, number and weight of pebbles for each group.

Group	Grade 1st	2nd	Male/Female		Pebbles	Weight (lbs)
1	1	3	4	0	830	3.8
2	1	3	0	4	1600	3.0
3	3	1	0	4	900	3.8
4	2	1	2	1	1000	2.0
5	2	2	1	3	1900	3.8

N = 19

In the second experiment, these first and second graders found that the bigger apple displaced more water than the smaller one. A principle for water displacement was formulated that stated, "The larger an object the more water it pushes up and out of the way as it takes its place."

Discussion

Kindergartners, first, and second grade students were taught to incorporate literature, mathematics, and science concepts in a meaningful context. These students were able to demonstrate critical thinking skills by combining analysis and synthesis of two fables and then writing a fable of their own creation. Furthermore, mathematical and scientific reasoning skills were used in tandem when they conducted an experiment depicted in the literature passage.

These learning contexts became meaningful when new information was linked to students' existing concepts, and became incorporated (integrated and related to other knowledge sources in memory) rather than remained compartmentalized (isolated due to lack of world knowledge and experience or due to rote memorization). Problem-solving lessons, using literature to learn about math and science concepts, provided learners with opportunities to engage in critical and imaginative thought and allowed meaning to be constructed in social contexts.

The role of imaginative literature is a powerful influence in students' intellectual development (Coles, 1989; Eanet, 1991). Learners need to

be provided with reading materials and lessons that stir their imagination and stimulate critical thinking in problem-solving contexts. In this investigation, literature contributed to science learning and reasoning ability in mathematics. Ideas were exchanged and social constructions emerged in the forms of verbal and written discourse, physical manipulations of apparatus and substances, and reasoning skills used by students that involved mathematical and scientific principles.

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