Introduction

The theme *Mathematics and Art* provided an avenue of opportunity for an elementary mathematics specialist and an art professor to collaborate in an effort to bring middle school students in one school in southeast Louisiana to a conceptual understanding of fractions as they were introduced to the concept early in the spring semester and two months before their battery of proficiency exams. Mathematics and art, sometimes considered opposites in the approach to learning, were instead viewed as a possible way of motivating middle school students to grasp a conceptual understanding of fractions. The construction of Chinese sled kites provided an ideal situation to stimulate the students' thinking in patterns and structures, two characteristics that are critical to both mathematics and art. This project could form the basis for a wealth of underlying mathematical concepts of fractions while providing interconnections between the two diverse fields. When mathematical patterns or processes automatically generate art, a surprising reverse effect can occur: the art often illuminates the mathematics. With visual representations of both disciplines, elementary and middle school students as artists use the mathematics, often exclaiming, "Now I see!" and "Now I understand!"

This project therefore addresses the integration of art into mathematics and a conceptual understanding of fractions, particularly the multiplication of fractions, using Chinese kites. It is believed by some that students can more easily learn mathematical concepts when motivated to do so in a meaningful, positive way That invokes deeper understanding of why the mathematics may be important (Copeland, 1974). Creative projects or projects that appeal to their "sense of play", such as kite making, can often be sources of motivation to learn more difficult concepts such as fractions (Piaget 1896, Sigel 1968). In many middle school educational settings, the introduction of fractions can be a monumental task. Often when a student fails to understand basic fractions, the response is remedial work. Too often this means, "Once again but slower and louder." By contrast, an entirely different strategy in the face of student difficulties could be to ask the students to, "Try this another way." Springman (2004) states that, rather than trying to "remediate" past failure, artists may provide students many ways to build up to success in seeing the need for fractions. The standards do not drop; the approach shifts. In her research, Martin (2005) contends, "When children are motivated through creativity of art, a springboard of connections can be provided for mathematical learning." These beliefs are further evidenced in the No Child Left Behind Act.

In January, 2006, motivated by a national emphasis on the integration of arts and mathematics in the schools, the author organized a collaborated project and a unit lesson plan with an art educator to observe two groups of students. The major emphasis was to use art and mathematics to construct a kite built by using proportions.

The three -day project proceeded as follows:

First Day

The visiting professor was introduced as an artist. Discussion followed with, "What is an artist?" And, "What does an artist do?" This beginning discussion by the artist was to invite the students to be comfortable with their imaginations. The objective was for the students to be led to their own realization that original, and sometimes strange, ideas come from the artist's imagination. Typical responses from the students were that artists "make things," and artists sing, write stories, paint, draw, build, dance, compose music, etc. One student responded that special artists also invent things. The artist led the students to conclude that all of these artists have to learn to use skills to make their art better. Another important concept she emphasized was that if an idea doesn't work right or doesn't sound right or doesn't look right, it is not necessarily a bad idea. If our ideas are not to our satisfaction, we may need to work hard to make them better. Sometimes we are more artists, and sometimes we are more scientists or mathematicians. On the first day students would be mathematicians, because no matter how beautiful the kite might be, it can fly only if it is measured and built correctly.

The discussion continued with the presentation of fractions as the essential element of this particular kite design. One half was the first fraction. When asked, "What does 1/2 of something really mean," students responded from the white board demonstration with, “One divided by two." The artist continued, "Our kite will be 1/2 as wide as it is long. It is 18 inches wide. So, can you figure out how long will it be?” When students responded with "36, the artist explained that this would be the same length of 36 inches on their yardsticks. The artist instructed the class to measure 36 inches at the top and at the bottom, draw a line and cut, then measure again. The artist asked, "Is your paper 1/2 times as wide as it is long?” "How do you know this?” "What if your paper were 24 inches long?” "How wide would it be?” "What would you do to find out?” The artist and mathematics professor both paid close attention to the number of students who got this answer. The artist continued with, "So you could build another kite exactly like this one, only smaller. Do you think it would fly also if you correctly use the fractions?” "What, mathematically, would allow the kite to fly successfully?”

The artist then directed students in the next step, to divide the 36 inches into equal parts of thirds. She asked students, “What does this mean mathematically?" "How can this be demonstrated?" Students responded with (1/3 X 36/1) = 12. The white board exercise continued with dividing the 36 inches into 2/3. "If 1/3 of 36 = 12, can you connect what 2/3 of the 36 inches would equal?" Students then responded with 24 inches (See fig. 1). Students reached this conclusion quickly. The artist then directed the students to use the yardsticks to mark 12 inches and 24 inches. One student responded that this means together that 3/3 = 36. It was at this point that both the artist and mathematics teachers realized most of the students in the class were experiencing difficulty in proper measuring, an unexpected result that required more time than originally planned, and, which in turn, distracted from the objective of further simplifying additional fractional parts. No significant delay resulted, however, and the concept of fractions remained the primary goal and the primary skill to be attained. The artist then led the discussion to dividing the outer third of the 36 into two equal parts (See fig. 2). This was written as (1/2 X 1/3) = ? "Is this a true statement"? "Why is this a true statement?" Students responded with 1/6, because (1/6 X 36/1) = 6. As the students continued in groups, the artist and mathematics professors could hear other students responding with their neighbors that this equals = 6. Students then used their yardsticks to mark both outer 12-inch sections at 6 inches from the edges. More important, they now understood the how and why for their calculations.

The discussion continued with the artist leading the students to divide the second six inch section on each side by two. The students were asked why and how this would happen. Students responded that from the (1/2 X 1/6) = 1/12. Student responses, which were reached very quickly, were recorded on the white board as (1/12 X 36/1) = 3. Yardsticks were used to mark the 3-inch space or 1/2 of the second section on each side, and the process continued to complete the drawing of the kite. The artist then directed the students to mark the bridle wings for the kite on both sides. The term "bridle" was defined in relation to kites, that is a length of line or cable attached to two parts of something to spread the force of a pull; *especially* **the** rigging on a kite for attaching line. A vent at the center bottom of the kite in the shape of an inverted triangle was constructed (see fig. 3). This activity again provided a time for additional vocabulary building. The students also learned that thirds were used in this portion of the kite building. After names were written on each kite, the first hour and a half session concluded with clean up and brief comments concerning the session that would resume on the following day. The students were asked to prepare by reviewing at home the meaning of the fractions

1/2, 1/3, 1/6, 1/12 and how these fractions could help build a smaller kite or a larger kite.

Second Day

The artist returned kites and yardsticks to the students and asked that they measure to review the proportions. As the art professor demonstrated the proper way to measure using the yardstick, students were asked to check their own kites. Thirty-six inches were established from top of bridle to top of bridle. In further review, the students recalled that the 36 inches were divided into 1/3 = 12 inches and (1/3 X 36/1) = 12 and (2/3 X 36/1) = 24 inches (see fig. 4). These measurements were checked. Some corrections were made. The class was reminded that they had then divided the outer sections by one half to which they responded that this meant (1/2 X 1/3) =1/6." This process continued, and each fraction and subsequent measurement was checked by each student on his or her own kite. This part of the workshop required fewer than fifteen minutes.

It should be pointed out that this class had worked very little on fractions with multiplication and had not been introduced to multiplication or division of fractions until this activity. No work with fractions had been introduced in the mathematics classroom.

Folding the kite at the 12-inch, 6-inch, and 3-inch marks on both sides was the next step (see fig. 5). Final folds were compared to wooden sticks on other types of kites for strength. While the folding was being done, the artist asked the students to tell what proportion was being used each time. The artist also would ask short problems such as "(1/2 X 1/12) was what?” The calculation took a few more seconds, but most of the class responded "1/24." The artist pointed out that we did not measure this amount, because it was more difficult to divide 36/24. The mathematics teacher and artist assisted the students with the folding process, and the entire class finished in ten minutes.

Stapling the ribs of each kite and checking for folding errors was the next process. Each correction was explained as the results of a drawing, rather than measuring, error. If a measuring error was found, the student was shown with the yardstick the correct measure and a review of the proportion was asked for. This process took another ten minutes. Conceptual errors were, in every case, failure of the student to remember multiplication tables and not a lack of understanding of the process of multiplying numerators or denominators. One student explained, in an almost apologetic response, that she and her mom were working on this at home. The artist commended her for the efforts and assured her that she would look for improvement before the kites were finished. When each kite was stapled, the student was asked to decorate the kite with any drawing of their choice. While the students drew, the artist taped the bridle tips with masking tape to reinforce these points for attaching the bridle string (see fig. 6).

The last presentation was the bridle string. After explaining the purpose of a bridle string, the artist explained that the string had to be 1 1/2 times as long as the stretched out kite. This proved to be too difficult for the students to compute, so the artist wrote: (1 X 36) = ? and (1/2 X 36/1) = ?

The artist was surprised when the students were able to respond with 54. Then the artist measured and cut the bridle strings 54 inches in length for each student. This concluded the second day for the experimental group.

Third Day

The artist returned the kites to the students and asked if anyone who had finished their designs would like to try to use the fractions to build a kite from the 24-inch pre-cut paper. Four students responded that they wanted to try. The diagram of the 36 by 18 paper was changed to 24 by 12. After reminding the students that the first division was thirds, the students were on their own until they had specific questions. As students finished their drawings, the artist attached the bridle strings through the masking tape installed the day before. This process took one hour, after which the artist continued to present basic multiplication of fraction problems on the board or called out problems for the students to answer without raising their hands. The students quickly called out the correct answers to such problems as (1/3 X 1/6) and (2/3 X 3/9). Occasionally the students would add numerators instead of multiplying, but quickly caught their own errors and corrected themselves.

By the end of the bridle installations, nine of the twenty-three students had asked to try the smaller kite construction. They received some help from each other, but all of the nine students were successful in developing the kite correctly. All derived their own measurements by multiplying the fractions in the same sequence as they had done with the larger kites.

When all the bridles were installed, the artist reminded the students of the purpose of the bridle. The next short discussion was on the stabilizers to be attached to the kite to keep it from spinning out of control. When a kite with a stabilizer was drawn on the white board and the class was asked what it is sometimes called, the students responded with "tail". The students named many things that fly and agreed that they all had tails, such as birds and airplanes. The artist explained that these would also not be able to have controlled flight without their tails or stabilizers. Once the stabilizers were attached to the kites with tape, a 15 - 20 foot guide string was attached to the bridle loop, and the kites were carried to the playground. Every student successfully flew the kite they constructed. This concluded the third day and the project for the experimental group. (Kite patterns with instructions and proportions for construction are illustrated at the end of this article)

Observations

Although the project was not a specific and formal research study, a pretest was administered the day before the project began. It consisted of items from the State Department of Education Iowa/*i*LEAP content released test items, the Grade Level Expectations, and the school district's grade level textbook. The test consisted of eight problems, which ranged from simplifying fractions, writing equivalent fractions and multiplication of fractions. A posttest consisted of the same items as in the pretest and was administered at the end of the project in attempts to validate the observations of the professors.

The mean for the group's pretest was 2.91, and the posttest mean was 6.01.

Conclusions

The integration of art and mathematics has a place in the curriculum. Important to mention is that the brevity of the experiment with Chinese Kites may emphasize any differences you observe, particularly if those differences are small. It appears that if this motivational and integrated format is used one time for three days, the impact should be less than if it were used over a longer period of time, as in the duration of the study of fractions. An obvious implication results that integrated mathematics content with other disciplines provides student understanding of the where and why of mathematical understanding. This appears to serve as a legitimate element of the project and supports the findings in an almost exponential amount

Summary

The successful flight of every kite by each of the students provided a powerful and meaningful experience with fractions and proportions (see fig. 7). Positive outcomes of integrating art with mathematics provided in this study support the premise that, when students develop conceptual understanding of mathematics through applications, as with integrated disciplines such as arts, the learning is individualized and personal, with each student motivated from within themselves to learn. This motivation is a key to increased and effective life-long learning in mathematics.

References

Copeland, Richard W. (1974). *How children learn mathematics, teaching implications of Piaget's research.* New York, Macmillan.

Martin, Hannah. (2005). Always arts in the curriculum. *Exceptional Children*, (34), 45-67.

Piaget, J. (1962). *Play, dreams, and imitation in childhood* (1896). New York, Norton.

Piaget, J. (1973). *To understand is to invent: The future of education* (1896). New York, Grossman Publishers.

Piaget, J. (1976). *The grasp of consciousness: Action and concept in the young child* (1896). Cambridge, Harvard University Press.

Sigel, I. E. (1968). *Logical thinking in children: Research based on Piaget's theory*. New York, Holt, Rinehart and Winston.

Springman, M. (2004) A call, a need in 2010 for developmental education. *Journal of Developmental Education, (*23) 4-21*.*

Figure 1 – Students are measuring the proportions.

Figure 2 – Marking the thirds of the entire width.

Figure 3 – Demonstrating the cut vents and stabilizers with bridle.

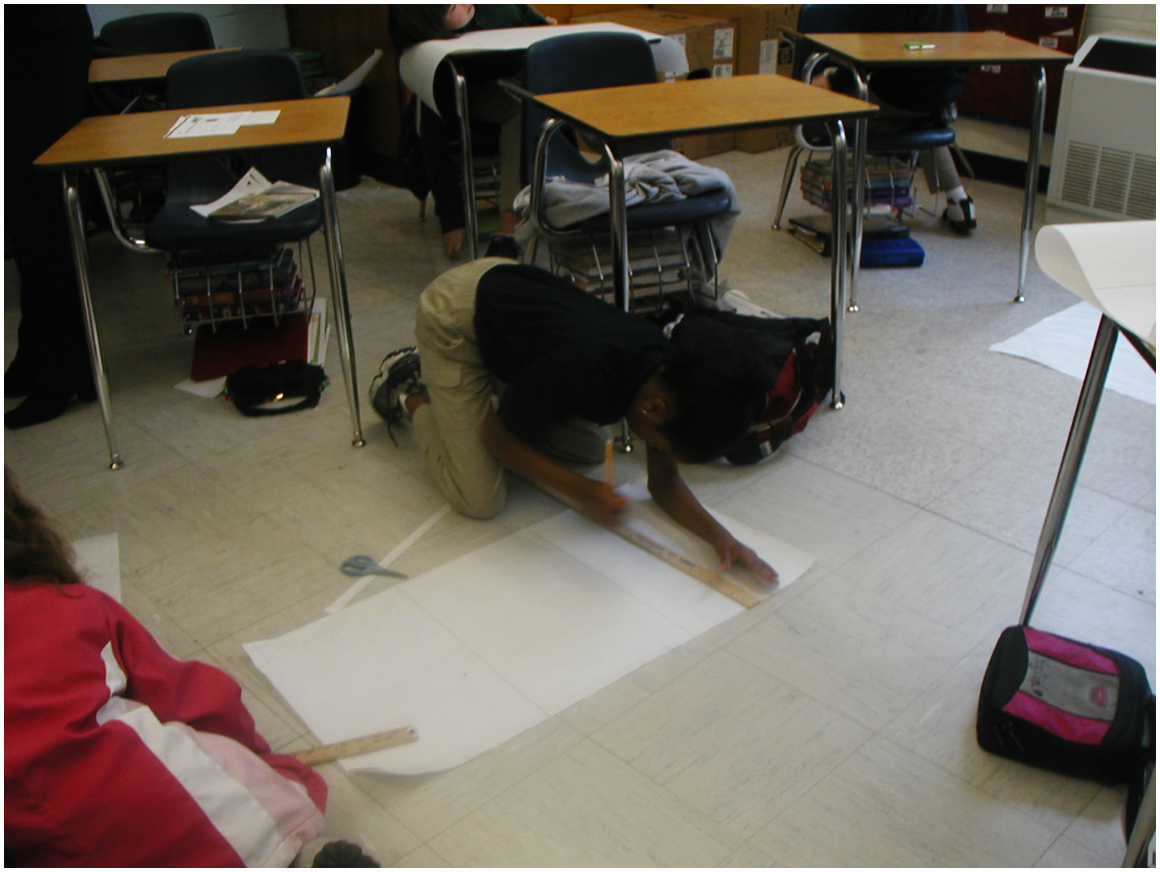

Figure 4 – Students confirm the measurements for folding and bridles.

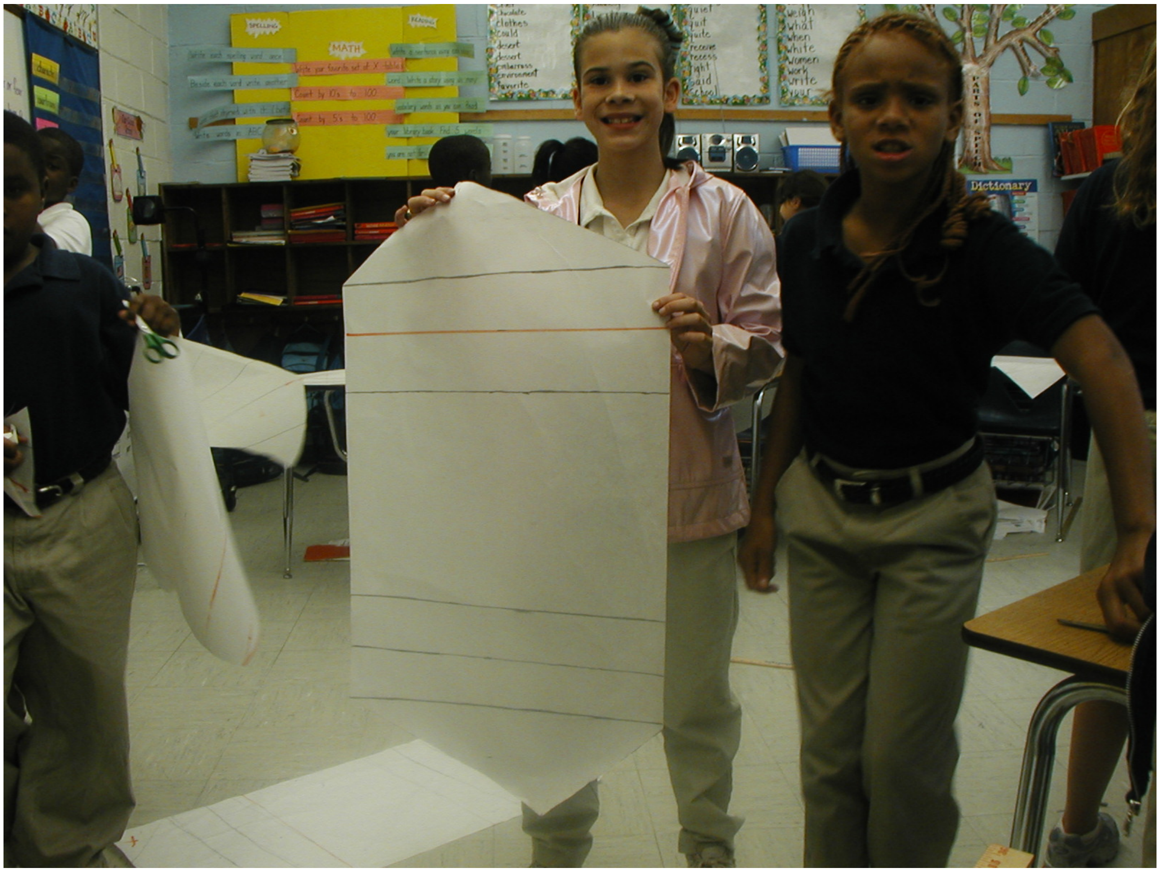

Figure 5 – Preparing to make the fraction folds.

Figure 6 – Preparing the bridles.

Figure 7 – All kites fly successfully.