Teaching Transformations of Functions using Modern Dance: An Experiment Pairing a Modern Dance Class with College Algebra

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Background:

The researcher's interest in finding ways to improve college algebra has led to a study of learning styles of College Algebra students. Since 77% of the surveyed college algebra students are more active learners than reflective learners, a new approach is needed. (The researched used the Felder-Soloman Learning Styles Index for this; a presentation was given at RUME 2005. Paper unpublished as of present time.)

The new liberal education requirements at my institution require students to take at least one pair of courses that are designated as "paired courses", which means that a student must take both courses in the same semester, and that the throughout the semester the information and skills learned in the one course will be cross-referenced in the other course.

A College Algebra course was paired with Modern Dance to enable students to learn both the dance and the math curricula, by using action to help understand the mathematics. The Modern Dance class, PEH 100, was paired with College Algebra, MAT 111. Each class covered the material of the class that would have been covered individually. Students received credit for each class individually. Modern Dance met two times a week, for 1 hour 15 minutes for half the semester. College Algebra met three times a week for 50 minutes.

This short paper will focus on the ways of teaching Transformations of Function in a kinesthetic way to the students in the class. The presentation will discuss both the learning that occurred and the student's attitude toward the subject.

Other math dance combinations

Although not many college algebra classes are paired with dance classes, math and dance have been linked previously. In the dance world choreographers have used mathematics. For example, Frederick Ashton choreographed ***Scénes de ballet*** in 1948 and the ballet was produced again in 2003 Covent Garden, London. It was said that Frederick Ashton " *arrived at rehearsals with a volume of advanced geometry under one arm and adapted theorems as floor patterns for the dancers."*

Teachers of elementary schools try to incorporate movement in their classrooms. One of the biggest studies done was reported in 2001. A dance instructor came to the classroom once a week. This showed a significant improvement in attitudes toward mathematics compared to the control group. (Werner. 2001)

Qualitative research

The class size was extremely small, with only 8 students, and only 7 students taking a pretest and a post-test on transformations of function. The method of assessing the impact of the pairing with dance on students was to have a pre-test and post-test of the material, and ask the students questions, utilizing in-person interviews and written responses.

Method for teaching transformations with dance:

The focus of this paper will be on the section of the math textbook on Transformations of functions. The material assumed the students had memorized the basic college algebra functions previously:

$f(x) = ax + b$

$f(x) = x^2$

$f(x) = x^3$

$f(x) = a$

$f(x) = \sqrt{x}$

$f(x) = \sqrt[3]{x}$

$f(x) = |x|$

The transformations were presented using the xy-coordinate system placed on the dance studio floor. Many, but not all, of our Algebra classes were held in the dance studio. The floor of the studio was fitted with a large scale Cartesian coordinate system by the use of masking tape of the floor.

The beginning of studying transformations began slowly. Students were asked to plot points by standing on the graph on the floor. The initial curve was $y = x^2$. Three students plotted the points for x = -2,0,2. The students then held hands to see the curves. See illustration below:

Three other students then graphed the same points for the curve $y = -x^2$. The instructor would then reinforce this with graphing on the blackboard and with the students doing their own graphs with pencil and graph paper.

A similar discussion/demonstration was presented for other functions and their opposites. Here is a picture of y = |x| and y = -|x| with the students lying on the floor. This corresponded with the ideas in Modern Dance of using three levels of space – low, middle and high. So sometimes in the demonstrations of math concepts we would stand and other times we would jump or get on the floor.

When it was time to consider y = a f(x), we moved to the mirrored wall of the dance studio. Each student used masking tape to put the x- and y-axes on the mirror in front of them, with the origin at shoulder-level. The students used arms to show the functions $y= x^2$ and $y = 10 x^2$ and $y = ½ x^2$.

Results:

The pre-test on transformations of functions consisted of 20 multiple choice questions, each worth 5 points. The pre-test results showed that the students had little information about transformations of functions. The range of grades was 15 – 30 and the mean grade was 21.4 .The post-test on transformation of functions was similar to the pre-test. The same type and number of problems were given. The post-test results showed the learning had taken place. The range of grades was from 40 points to 90 with a mean of 69.. The average gain was 47.9 points out of 100 points.

The students' attitudes towards math changed also. One student said that this was the first math class she ever enjoyed. Another student remarked that this was her favorite class of the semester and she never wanted to miss class.

Some comments from the students:

- "I figured I'd give math and dance a try since part of the class was to be taught through dance, something I was somewhat good at. I took the paired class because I would take anything that could possibly help me with math"
- "I learn better in groups and definitely anything hands on."
- "The most enjoyable homework assignments were the ones that were dance projects."
- "I learn best with hands-on activities, no matter what the subject area is."

Final comments

I was surprised that students in interviews mentioned that they enjoyed the visual aspect of the dance as opposed to the kinesthetic aspect. It was an amazing class and provided some students with their first success in math.. I would like to extend this research in many ways, especially with more students. There is always the possibility that the Hawthorne effect made the class go so well. Just the idea of being part of an experiment may have helped the students. Also when there are reluctant math students it helps to have fewer of them, so the instructor can see where they make their mistakes and correct them quickly. Of course, not every student loved the class. Two students did poorly over all: one because she did not come to class, another who came to class but did not put any time in studying outside of class.

Another extension of this research would be to try to include even more dance. One student mentioned that she was sure every item in the College Algebra syllabus could be expressed with dance. Another extension would be to combine College Algebra or other types of mathematics courses with other arts – visual, other performing arts. Robert Speisey at Brigham Young University has been teaching a non-traditional Calculus class to dance students and some of them have used the mathematics in their choreography.

College Algebra classes would also be interesting if they were to take on another topic – sports and College Algebra, or a specific sport and College Algebra.

Would I do this again? Yes. The students' remarks were positive and for some students it changed their way of thinking about mathematics. Their attitude towards math has improved immensely. The result for this instructor is that I will use as many different ways of presenting material as possible, with an emphasis on visual and kinesthetic ways in College Algebra. Even when I do not have a dance aspect to the course I will haves students make their arms form a parabola or have groups of students stand in the shape of a curve. Any time I can have my students move I will do it.

Selected References

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