Marine Math at the Texas State Aquarium

A PROPOSAL for a PROJECT in MATHEMATICS

by

ERIN SAENZ

APPROVED: Elaine Young Date: 5-26-09
Dr. Elaine Young, Chair

George Tintera, Member

Denise Hill, Member

Style: APA format
ABSTRACT

In order for high school students to compete and survive in the 21st century, knowledge and proficiency in mathematics are critical. One of the greatest challenges for mathematics teachers is convincing students that there is a place for mathematics in the real world. At the middle school level, students should see mathematics as exciting and useful. Students can acquire, gain an appreciation for, and develop an understanding of mathematics if they have frequent encounters with interesting and challenging problems, as well as experiencing mathematics in the world around them. Mathematical field trips can be an excellent resource to support student learning, motivation and engagement.

The purpose of this study will be to explore and create a mathematical field trip to the Texas State Aquarium that will enrich middle school mathematics and engage students in interesting mathematical activities. Researchers have documented the cognitive and affective benefits of field trips, including increased motivation for learning (Kern & Carpenter, 1984) and the acquisition of knowledge and skills (Mackenzie & White, 1981).

This project will produce two lesson plans and one field guide for each grade 4 through 8 to further the resources available for middle school teachers in the South Texas region; help motivate students, and provide opportunities for a successful mathematics education. After the field trip and lessons, teachers should see an increase in interest and success in the classroom.
INTRODUCTION

In order for high school students to compete and survive in the 21st century, knowledge and proficiency in mathematics are critical. Today's graduates need to have solid mathematics skills whether they plan to attend college or enter the workforce. The need to understand and be able to use mathematics in everyday life and in the workplace is necessary for success. The level of mathematics necessary for many jobs in this economy has increased and is continuing to increase (THECB, 2007). Mathematics is used daily in such tasks as making purchasing decisions, cooking, and driving. The bottom line is that everyone needs to understand some level of mathematics to be successful in life.

One of the greatest challenges for mathematics teachers is convincing students that there is a place for mathematics in the real world. Teachers are always asked, "When will we ever use this?" Teachers must provide students with the best mathematics education possible which will enable them to be successful citizens and to achieve their career goals. Teachers must look at how students will use mathematics in the future and how it will fit into their lives in a meaningful way (NCTM, 1989). Finding different ways to excite and engage diverse students in mathematics classes is one of the most difficult challenges of being an effective mathematics teacher.

At the middle school level, students should see mathematics as exciting and useful. They should see the relevance and importance of learning mathematics in order to better their future. The Principles and Standards for School Mathematics (NCTM, 2000) proposes an ambitious and rich experience
for middle-grade students that prepares them to use mathematics effectively in quantitative situations in their lives outside school as well as laying a foundation for mathematics in high school. Students can acquire, gain an appreciation for, and develop an understanding of mathematics if they have frequent encounters with interesting and challenging problems, as well as experiencing mathematics in the world around them.

Mathematical field trips can be an excellent resource to support student learning, motivation and engagement. Field trips involve real-world experiences where students leave the confines of the classroom to observe mathematics on a firsthand basis (Paist, 2008). Such trips may include a local bakery, a construction site, or a bank. Dan Allison, the chair of the Nevada Natural Resource Education Council, states that field trips offer:

- instructional opportunities and content not available in the classroom;
- motivation for students that need an eye opener to the real world;
- just-in-time, inquiry-based learning;
- experiences to match different learning styles and intelligences; and
- connections to the students’ community

A good field trip provides students with firsthand experience related to the content being taught. They should return to the classroom excited about learning because they better understand the connection between what they are learning and its relevance in their own life. Giving students the opportunity to see mathematics in a context which can be applied and developed is a great way to show students the importance of learning and being successful in mathematics courses.

The purpose of this study will be to explore and create a mathematical
field trip to the Texas State Aquarium that will engage students in enriched mathematics activities. The materials will be aligned with the state’s standards (Texas Essential Knowledge and Skills) for mathematics, and be based on mathematical scenarios at the aquarium. This project will be based on the following guiding principles:

1. Mathematically rich and engaging lessons will excite and motivate students about the importance of mathematics in their life and future.
2. A hands-on experience, outside of the classroom, will support mathematics learned in the classroom and motivate future learning.
RELATED WORKS AND JUSTIFICATION

In many classrooms, two types of students usually exist: those that are naturally excited and eager about learning, and those that need that extra push to motivate and inspire them to learn. There are many factors that can affect a student's motivation to learn, including interest in the subject, desire to be successful, and perception of the subject's usefulness (Davis, 1993).

Dewey promoted hands-on learning, or experiential education. Experiential education is a philosophy that focuses on the process between teacher and student involved in direct experience with the learning environment and content (Neill, 2005). Neill further stated that students should be involved in real-life experiences and tasks and they should learn through experiences. He thought that history could be learned through experiencing how people lived in a different time era. In mathematics, he believed proportions could be learned through cooking. Dewey believed that students need educational experiences which enable them to become valued, equal, and responsible members of society. He proposed that education be designed on a theory of experience that includes the notions of continuity and interaction. Continuity is the notion that people learn and survive from every experience, good or bad. Each experience is therefore stored and carried in the future with every person.

The second notion of the theory is interaction. Interaction explains how past experiences interact and affect the present situation. Teachers can take both notions and design lesson plans that will be both memorable and positive for
their students. A field trip can support Dewey’s philosophy by providing a hands-on experience that is active and relevant to the learner and the concepts taught. While many students may have visited the Texas State Aquarium before, they probably did not view the experience with mathematical eyes. Hopefully, they will take the experiences and knowledge gained with them to their future mathematics classes.

Foothill High School math teacher John Hagen was faced with the challenge of motivating a group of students who couldn’t pass in a traditional school, had criminal records, or were teenage mothers or fathers. Knowing they all had their own real-life challenges outside of school, he knew he needed to use something other than the traditional textbook in order to reach them. His solution: fantasy football. The lesson is based on NFL statistics in which students have their own football team and must plug football statistics into mathematical formulas. Hagen found that not only did his students pay attention in class, but they were also willing to do their work in class. Hagen’s lesson is just one way in which to get students interested and motivated in the subject of mathematics (Barr, 2006).

A field trip is defined as "a trip arranged by the school and undertaken for educational purposes, in which the students go to places where the materials of instruction may be observed and studied directly in their functional setting: for example, a trip to a factory, a city waterworks, a library, a museum, etc". (Krepe1 & Duvall, 1981, p.7). Field trips bring curriculum subjects to life. Students need hands-on, real-life experiences to support their classroom studies (Michie, 1998).
Field trips engage and even entertain students, helping to make educational experience more relevant, memorable and meaningful (Scarce, 1997).

Researchers have documented the cognitive and affective benefits of field trips, including increased motivation for learning (Kern & Carpenter, 1984) and the acquisition of knowledge and skills (Mackenzie & White, 1981). A number of values were mentioned by teachers in terms of student outcomes: cognitive, affective, firsthand experience, variety, and motivation (Hurley, 2006).

The Oregon Wood Magic Program was used as a field trip experience for third and fourth graders in order to determine the cognitive effects of participation of the field trip. Students participated in a three-hour, hands-on workshop on biology on the campuses of Mississippi State University and Virginia Tech. Students were tested prior to the trip, post-tested within a week following the trip, and tested again three months later. Results showed that students not only increased their knowledge after their experience, but they also retained their knowledge over time (Morrell, 2003).

Field trips also serve as a memorable experience for some students. Some students are exposed to new and exciting places through school trips that they would not have been able to take on their own. Research shows that 96% of all people questioned recalled their school trips (Falk & Dierking, 1997). In a 2004 study, four men and four women between the ages of 25 and 31 were interviewed about their own field trip experiences. The participants shared the thought that field trips have a positive impact on student ability to recall information learned on the trip, and that they enjoyed trips that encompassed
hands-on activities. The data also showed that trips which take students out of the classroom and into the real world are both educationally and socially beneficial for participants (Pace, 2004). Students who are actively involved in a field trip experience tend to demonstrate a better understanding of the course materials following the field trip. Experiences that children have while participating in a field trip produce memories that stay with them long after the trip (Knapp, 2000). The experiences should get them involved and connect them to the curriculum in the classroom, the real world, and possibly to things they would have never seen. The memories can possibly change their lives.

In 2006, Target Corporation launched the Target Field Trip Grants Program in order to help provide educational resources for America’s teachers and classrooms. Teachers were allowed to choose their own field trip and use the money to take learning outside of the classroom. Members of the Target Teaching Circle surveyed teachers and asked their thoughts on the benefits of field trips. The teachers surveyed stated the following top field trip benefits: improved student behavior (83%), creation of special memories and bonding experiences (56%), broader student understanding of current issues in today’s society (42%), and increased student understanding of, and interest in, a subject (40%) (Winkler, 2008).

A field trip can be used as an extension of the curriculum taught in the classroom. Trips should be connected to classroom lessons. For a field trip to be effective, teachers need to adequately prepare for the trip. The learning that takes place during a field trip is optimized only when teachers plan and
effectively integrate the curriculum within the trip. Materials such as lesson plans, activity ideas, primary documents, and information obtained from field trip sites can be of great help to educators in preparing lessons for a trip. These materials can help teachers support a deeper level of learning from a trip. In a study, fourth-grade teachers in the Hudson Valley region of New York State were asked about the type of materials they would like field trip sites to make available to them. More than 50% of the teachers surveyed indicated that they preferred to have short activity and lesson ideas made available to them before the planned trip. They also preferred the materials in hard-copy form and adaptable to a variety of classroom situations and subjects. Some educators said that materials specifically created for pre-trip lessons were the most valuable tool for them (Noel, 2007).

Five goals that all students learning mathematics should pursue are learning to value mathematics, becoming confident in their ability to do mathematics, becoming mathematical problem solvers, learning to communicate mathematically, and learning the reason mathematically (NCTM, 1989). With field trips, all five goals can be accomplished.

This project is appropriate for a project for a master's degree in mathematics because it will provide resources so that field trips can be an important component in mathematics education in order for students to experience mathematics in the real-world and to ignite and enhance their interest in their own mathematics education. This project will identify mathematics that students can do and learn, related to the aquarium activities, that may not be
obvious to the casual observer. It will also provide teachers the necessary tools and resources needed for a successful field trip experience to The Texas State Aquarium. It is important for students to be able to experience mathematics outside of the four walls of their classroom and see it in action.
PLANNED ACTIONS

The project will begin with the researcher's visit to the Texas State Aquarium to become familiar with the layout and to brainstorm mathematics activities. The researcher will produce lessons and a printed field guide to prepare for and enrich the aquarium field trip. The lessons will target grades 4 through 8 at the request of the Texas State Aquarium because of the benefit such a trip can give to that age group. The lessons will be aligned with school district and state standards and goals. There will be two lessons per grade level: a pre- and post-trip lesson. The pre-trip lesson will consist of preparing the students for the trip and giving them an insight into the mathematical activities they will experience at the aquarium. The post-trip lesson will be an assessment of the real-life experiences and mathematical objectives learned. The field guide will be used the day of the trip at the aquarium; each student will complete the field guide as part of their experience. Each grade level lesson and field guide will be created to engage and enhance student understanding and awareness of the importance of mathematics in order to function successfully in their lives and careers.

The lessons will target the four objectives with the lowest success rate per grade on the mathematics portion of the TAKS (Texas Assessment of Knowledge and Skills) test. The mathematics portion of the TAKS test in grades 4 through 8 contain six objectives that are aligned with the TEKS curriculum and are the foundation skills necessary for high-school level mathematics courses. The four objectives with the lowest success rate matched that of the local district data and
statewide data. Interestingly, grades 4, 5 and 7 all have the same four objectives with the lowest success rate, as do grades 6 and 8 having the same objectives (see Tables 1 and 2).

Table 1: Objectives with lowest success rate for grades 4, 5, & 7

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<thead>
<tr>
<th>Objective</th>
<th>Description</th>
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<tbody>
<tr>
<td>3</td>
<td>Geometry and Spatial Reasoning</td>
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<tr>
<td>4</td>
<td>Measurement</td>
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<tr>
<td>5</td>
<td>Probability and Statistics</td>
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<tr>
<td>6</td>
<td>Mathematical Processes and Tools</td>
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Table 2: Objectives with lowest success rate for grades 6 & 8

<table>
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<tr>
<th>Objective</th>
<th>Description</th>
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<tbody>
<tr>
<td>1</td>
<td>Numbers, Operations, and Quantitative Reasoning</td>
</tr>
<tr>
<td>2</td>
<td>Patterns, Relationships, and Algebraic Reasoning</td>
</tr>
<tr>
<td>4</td>
<td>Measurement</td>
</tr>
<tr>
<td>6</td>
<td>Mathematical Processes and Tools</td>
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The lessons and field guide will concentrate on the above objectives per grade level to try to increase the passing rate on future TAKS tests. If the
students experience these objectives in a different way other than they are used to, they may become more interested and more successful at mastering the problems.

TIMELINE

<table>
<thead>
<tr>
<th>March - May 2009</th>
<th>Prepare Project Proposal</th>
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<tr>
<td>May 2009</td>
<td>Distribute Project Proposal to Committee Members</td>
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<tr>
<td>May 2009</td>
<td>Project Proposal Defense</td>
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<tr>
<td>May - June 2009</td>
<td>Research TAKS data and lessons</td>
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<tr>
<td>June - July 2009</td>
<td>Create lessons</td>
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<tr>
<td>July 2009</td>
<td>Distribute Project to Committee Members</td>
</tr>
<tr>
<td>August 2009</td>
<td>Project Defense</td>
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END RESULTS INTENDED

This project will produce two lesson plans and one field guide for each grade 4 through 8 to further the resources available for all teachers in the South Texas region and to help motivate and show the value of a successful mathematics education. The publication of this packet will be available to school districts, teachers, camp leaders, Boy and Girl Scout leaders, and other youth groups to implement into their curriculum and activities. These materials will be available on CD upon request and on the Internet as well as disseminated through the school districts and Aquarium. Teachers will have the lessons and field guide readily available to print and distribute to their students as needed.

After the field trip and lessons, teachers should see an increase in interest and success in the classroom. Since the students experienced mathematics in a different and fun setting other than their classroom, they should have been able to retain the information. Students should return to the classroom with a greater understanding and knowledge of the concepts learned and therefore will perform at a higher success rate on assignments and tests. They will also see how mathematics is relevant and important and is not only seen in the classroom and in textbooks, but in real-life in such things as aquariums, starfish, and turtles.

Results may include a greater appreciation of mathematics by all students. Students will hopefully see mathematics used in the real world, including various career choices. Career choices may be made as a result of various field trips. Mathematics should be much more appreciated by all and it should be taken
more serious in mathematics courses throughout the student's life. It is the ultimate goal of the author to encourage all teachers to incorporate field trips within the mathematics curriculum.
BIBLIOGRAPHY


