ENGAGING MINORITY STUDENTS IN MATHEMATICS ACTIVITY VIA A "MATH FUN DAY"

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ABSTRACT

The achievement gap between minority students and their non-minority peers is a complex problem that revolves around the issue of self-perceived efficacy to do math. The result is that many Blacks and Latinos avoid upper level math courses and STEM-related careers. Suggestions for remediating this problem point towards out-of-school activities where students actively talk about math within a social support network of friends, parents, and teachers. Schools and collegesacross the world have tried a number of events (e.g. *Math Olympics*, *Family Math and Science Nights*,*Pi Day*, and*Sofia Kovalevskaya Day*) to try to change attitudes and convince students that math is beautiful, fun and powerful.

UMES is a historically black university well situated to discover ways to change minority attitudes about math. For three years their Math Dept. held an event called "Math Fun Day" that provided out-of-class enrichment and fostered the development of a social support network. During a 3½ hour time slot, students had a choice of up to five different 50-minute workshops presented by seniors taking their research capstone course or faculty. All workshops featured rich tasks where math talk was encouraged. Math Ed majors were recruited across all classes (Freshman to Senior) to serve as greeters, guides, and room monitors. Positive results were that the number of attendants grew each year, students thought workshops were fun and interesting, sessions were alive with animated conversation about the math, and students cultivated support networks of friends and instructors. Somenegatives were that not all faculty supported the event, which meant that Math Fun Day took a large commitment of time and energy for just a few faculty.

BACKGROUND

The achievement gap between minority and non-minority students with respect to mathematics has been an issue for the past three decades. Many factors contribute to minorities' low-achievement, but self-imposed low expectations are often cited as a major concern. According to Steele (1997), "minorities tend to develop a perception of their ability, intellectual performance, and identity of self based on stereotypes that pertain to their group." He contends that social identity becomes significant whenever a person is treated according to that stereotyping, thus affecting not only their opportunities for success but also the perceived self-identity of each individual group member. Typical stereotypes begin as early as kindergarten, when teachers form generalizations about the characteristics of minority students, and then subsequently use these beliefs to determine what they expect of children. Complicating the issue is the fact thatmost minority students have their own understanding of their cultural group. They tend to perceive that groups of people with similar cultural identities have their place within the ordered workings of the larger society (Ogbu, 1991; Martin, 2000).Such societal stereotypes, not solely mathematical proficiency, impair standardized test performance of minority students. In short, negative stereotypes (e.g."Blacks do poorly on achievement tests") create a situational pressure that actually depresses academic performance (Ryan & Ryan, 2005).

Unfortunately, poor academic performance and the lack of being able to "see" oneself as a potential mathematician has led to a disproportionately lower number of minority students studying mathematics. "Far too many students in the U.S. give up on math early because it does not come easy and they believe only students with innate ability can really be 'good' at mathematics. Most American middle school students (84 percent) would rather clean their rooms, eat their vegetables, take out the garbage and go to the dentist than do their math homework" (Achieve, 2013). Yet these same students claim they want to do better in math (67 percent) and also believe that doing well in math is important (94 percent). This situation is even more pronounced among Black and Latino students, who are greatly underrepresented in upper-level high school math classes in the United States, a fact which has serious implications for their academic achievement and futures (Walker, 2007).

For minority students who manage to attend college,most tend toavoidmajors in the STEM disciplines (Science-Technology-Engineering-Mathematics) due to their self-perceived deficiency in math.In fact, students in general share

this attitude. In a report describing attitudes and motivations of all groups of first-year college students nationally at the beginning of the undergraduate experience,Noel-Levitz, Inc. (2011) found that "more than 44 percent of incoming freshmen nationally agreed with the statement, 'Mathhas always been a challenge for me,' with even higher percentages agreeing among first-generation freshmen (48 percent) and adult, nontraditional-age freshmen (53 percent)."It is worthy to note that the majority of first-generation freshmen herald from minority populations.

Thisrelationship between attitude and self-efficacy in math was studied by Rice, Barth, and Guadagno (2013) in a large cross-sectional project. They gathered data from 1,552 participants in school settings from 5th grade to college. Findings suggested that students who experienced greater social support for mathfrom those around them (parents, teachers, and friends) had:1) a more positive attitude toward math, and 2) a higher sense of their own competence in these subjects.This study implied that supportive experiences might encourage minority students to take upper-level mathematics courses and at least consider STEM-related careers. Indeed, Walker's (2007) research revealed that minority students doing well in math often drew on networks of family and peers that supported this achievement.

One might likely ask: What instructional strategies and support can universities offer to encourage students, especially minorities, to change their attitudes and see their own potential to do mathematics? Walker (2007) providessix basic suggestions for encouraging more Black and Latino students to take higher-level math courses. One of her ideas is that educators need to expand enrichment opportunities by providing more out-of-classroom mathematics experiences. Because many parentsoften believe that only a few individuals can do advanced mathematics, there is often a lack of opportunityfor their children to do "real" mathematics activities at home or outside of the classroom.Thus, the most critical adults in minority children's lives offer neither support nor occasions to grow mathematically.

The mathematics community has responded to this dual need of providing students with out-of-school activities and a social support network in a variety of ways. From elementary to college, students can participate in camps, special math days, and engage in many activities that are designed to build both content knowledge and self-confidence in math. Universities have shifted from institutions that provide basic math instruction to ones that create environments and experiences that help students discover knowledge for themselves. This combination of arts, music, and general life interests whiledoing mathematics has helped students balance their education with a combination of creative imagination and logic (Bi1ler, 1995).

EXAMPLES OF ACTIVITIES THAT SUPPORT STUDENTS' APPRECIATION OF MATH

It's a fact:Math is everywhere! Mathematics is "a way of describing the world--a way of thinking, knowing, and problem-solving" (Virginia's Early Childhood Development Alignment Project 2008). So, how do we engage students in math classes? How do we convince them that math is beautiful, fun and powerful?Greenberg (2012) suggests that we make the math that occurs in daily life concrete and visible. She believes that this is done through math talk. Talking is to "know" what math is involved and how it contributes to understanding the world around you. Enrichment activities that include math talk whileactually doing math offer the greatest potential for changing attitudes and developing support networks.

For the math department at the Boston Arts Academy (BAA), the answer to encouraging higher math interest has been to infuse creativity into math classes. While still concerned with math standards and content, they focus on whether students have a chance to make choices and connect to their other passions. They "have realized that students also need to feel some sort of creative opportunity in order to feel engaged. This means teaching content within a project-based approach" (Lonergan, 2007).Although they introduce traditional math skills, practice those skills, and take tests and quizzes on these skills, students consistently talk about their projects and finally make presentations of their findings. Throughout the process, they are supported by peers, parents, and teachers.

Another opportunity for developing support networks of friends, parents, and educators is the *Math Olympics*activity occurring in many schools across the USA. Billed as "Mathematics Fun for Communities of Children and Adults," the *Olympics* bring people of all kinds together to experience and talk about "good mathematics." It features an evening of fun hands-on mathematics and problem solving scheduled for one night a week for four weeks. (Kundert, 2000).

*Family Math and Science Night*sare a similar kind of after-school event that engagestudents and parents in active investigations tied to the curriculum in a fun, informal environment. "Through this program, families actively explore math and science ideas, discover together through guided inquiry, and apply their discoveries to solve a

problem at the end. All activities are hands-on, use readily available and affordable materials, and focus on a theme that links science and math to the real world" (Sullivan & Hatton, 2011). Talking about math is critical throughout the process, and as students, parents, and teachers support each other through the investigations, attitudes about potential to do math and future course-taking behaviors are influenced in a more equitable, positive manner.

Pi Day and *Pi Week* festivities are celebrated around March 14 (in honor of 3.14, or the value of π) in many mathematics classrooms across the world. Resources for holding these activities abound on the internet and in teacher professional journals. Most ideasinvolve interesting real-life math connections and encourage conversations between peers and their classroom teachers. However, Daire (2010) suggests thatalthough these festivities are a good place to start, they can be a springboard to more frequent math celebrations. She believes "celebrating mathematics should be a yearlong event in which students in mathematics classes of all levels engage in activities and competitions that encourage growth in mathematical knowledge, enthusiasm for the subject, and collaboration among students of different abilities and backgrounds." Dairedeveloped a program called *Mathlete Boot Camp* in which students participate in six major celebrations during the school year that involved much more than the mathematics department. The ultimate goal of the six *Mathlete Boot Camp* monthly celebrations was for students to learn and have fun.

At the college level, many universities hold a *Sofia Kovalevskaya Day*. Sofia Kovalevskaya (also known as Sonia Kovalevsky) was a great mathematician, but also a writer and advocate of women's rights in the 1800s. Her struggle to obtain the best education available began to open doors at universities to women. In addition, her ground-breaking work in mathematics made her male counterparts reconsider their archaic notions of women's inferiority to men in such scientific arenas. A celebration in her honor usually involves presentations by female math professors, student discussion forums, and activities aimed at developing an explicit support network for budding mathematicians.

A college-level Swiss event based on "find the rule" problems has been part of the University of Canberra Maths Day since 1985. The UC Day "aims to be an exciting, enjoyable, light-hearted but nonetheless challenging day which provides the opportunity for students to celebrate their talents" (Clark & Brooks, 2004). They offer a variety of contests and games where students compete in school team groups. This large event involves considerable discussion of mathematical topics while fostering an inter-related support network of students, parents, teachers, and professors.

At Northern Kentucky University in April 2009, Noblittand Buckley introduced an activity based on the CBS hit show "The Amazing Race." Components included teams, pit stops, clues, time limits, fast forwards, challenges, and prizes.The *Amazing Mathematical Race*was held in recognition of Math Awareness Month, which was advocated by the Joint Policy Board for Mathematics. The race was the culminating event of the month for the university's Math and Stats Club. Teams of two people each competed in a series of ten mathematics-related challenges set up throughout the university campus. The goals of this event were twofold: to hold an activity that featured mathematics in a fun and exciting environment and to highlight this fun environment for people who are typically wary of mathematics.

THE UMES ATTEMPT

The University of Maryland Eastern Shore (UMES) is one of four research/doctoral degree granting institutions in the University System of Maryland. It is an 1890 Land Grant Institution and a historically black university with a total enrollment of over 5,000. Approximately 90% of the student body hails from the minority population of Black and Latino. The major academic challenge for UMES's Math Dept. over the past decade has been consistently decreasing student success rates in mathematics. About 50% of the students who take the two lowest levels of General Education courses in math fail the first time through and approximately 35% of them have to take these courses at least three times in order to pass.In spite of efforts to get students into STEM majors, this low success rate has led to a significant problem in terms of student retention across all STEM disciplines.Inability to meet the Math Gen Ed requirement also raises the potential for dropping out and was a leading cause of low graduation rates.UMESis obviously well situated to discover ways that might change minority student attitudes and encourage them to see their potential to do mathematics.

Understanding the need to provideout-of-class enrichment activities that foster a social support network of friends and instructors, the Math Dept. chose to adapt the models used by other schools/colleges to design an activity of their ownutilizing available resources. The event was called "Math Fun Day" and was offered four times during the three year period from 2010-2012.The goals of this activity were to: 1) engage students in rich mathematical tasks, 2) get them talking about math to each other, 3) provide role models of slightly older peers who were similar to themselves but were obviously proficient in math, 4) develop support networks between students of all ages across disciplines and faculty, 5)

help students see that math was everywhere around them in the real world, 6) encourage freshman to consider taking upper-level math classes and introduce them to possible STEM-related careers, and 7) show that math is fun!

Math Fun Day was advertised two weeks in advance with flyers around the halls of the Math Dept. and announced in every math class, regardless of level.Basic components of event were as follows:

1) Math Fun Day lasted for 3½ hours (from 9 AM – 12:30 PM) on a Thursday asstudents had free schedules at this time (UMES never offers classes during Tues-Thurs "University Hour" from 11:00 AM – 12:00 PM).
2) During the course of Math Fun Day, two to five different 50-minute workshops ran simultaneously, andstudents who attended were able to choose any workshop they wanted. The maximum possible number of workshops a participant could attend under these time constraints was therefore three.
3) Students earned a small amount of extra credit in their regular math course for attending. Most instructors required a written synopsis of what was learned in each workshop in order to receive this credit, and the amount earned was flexible. For instance, a student could attend one workshop for 5 points, or three for 15 points.
4) The workshops varied each year and presenters were drawn from two sources:
    a. Students in the research capstone course (Math 490) that all math majors were required to complete for graduation. Seniors in this coursecompleted high-level research on a math topic of their choice, wrote a cited paper suitable for publication, then showed their grasp of the topic by simplifying the material in a manner that was understandable to a diverse student audience. They createda 50-minute presentation for Math Fun Day, learned to make Microsoft PowerPoint slides,and designed a related hands-on activity for participants in their workshop. During Math Fun Day, Math 490 students repeated their workshop three times for the different groups of students who rotated into their room throughout the morning.Topics over the years included fractals and take-home paper models, probability and gambling outcomes withstudents rolling dice and counting cards, gaming theory and predicting outcomes on an online game, the golden rectangle and its use in photography, physics/vector theory followed by a paper airplane throwing contest, musical theory and using math to play tunes on glasses filled with varying amounts of water, and many others interesting ideas.
    b. Two Math Dept. faculty. Students watched a video on the Platonic Solidsand folded paper to make their own take-home dodecahedron. The Math and Computer Science Club (with their advisor) gave a demonstration showing participants how to program and move a robot across the room.
5) Math Education majors were recruited across all classes (Freshman to Senior) to serve as greeters, guides, and room monitors. They weregiven an identifying name badge, assumed leadershiproles, and were asked to stay forhalf an hour after Math Fun Day was over to eat together. For their service, Math Ed majors received a small honorarium (contributed by the Math Dept.)
6) A free lunch of Pizza "Pi" andsoft drinks was served from 12:00 – 12:30 PM to all attendees, presenters, and Math Ed majors (funds supplied by the Math Dept.)
7) Attendance was taken in every workshop (sign-up sheets supervised by room monitors). These records were provided to students' respective math instructors so they could receive extra credit.

RESULTS

The results of Math Fun Day can be divided into three categories, those outcomes experienced by students who attended the event, the effect of the activity on the presenters of the workshops, and the impact of the event on those responsible for organizing it. Although for the most part, reports were positive, a few negatives were noted. Data on outcomes was obtained from attendance, student comments on the synopsis of workshops, and observations.

First, there was a significant increase in attendance. Numbers grew from 47students at the first Math Fun Day to 125 on the last (fourth) event. As promotion of the event within the Math Dept. did not change from year to year, this growth is an indication of word-of-mouth advertising and repeat attendees. Students who came the first year told their classmates and younger peers about their experience and encouraged them to attend following years. We also noticed that once a student had attended the activity, about 20% of them continued to revisit Math Fun Day the next time it was offered.However, once they had completed their math course sequence and extra credit points were not applicable to their current schedule, that particular student's interest in attending the event waned.

Written comments were uniformly positive. For instance, they included the following:

- I enjoyed each session and experienced that you can have fun while learning math.
- I found the workshops very interesting and learned things I never knew before.

- I learned that everyday things are composed of math!
- Math can be a lot of fun!
- Overall it was a great experience because I gained a more hands-on feel for math and how it applied to everyday life.

Observations of student behavior by workshop presenters, Math Ed majors, and faculty during Math Fun Day echoed a common theme. Participantsappeared to enjoy doing rich mathematical tasks. Every session was alive with animated conversation about the math involved. Students supported each other to complete hands-on activities and engaged in friend-making behavior (e.g. asking each other about living situation, major, etc.). They posed questions about the material and seemed to take pleasure in the interactions with their role models (the Math 490 students).

The effect of Math Fun Day on the presenters of the workshops was consistently positive. First, the graduating seniors in Math 490 appreciated the chance to learn to use PowerPoint. As Math majors, 75% of them reported that although they had expertise in solving math problems, they had never learned this technology nor made an oral presentation with slides. The other 25% knew the technology, but valued the additional chance to practice giving a presentation before they graduated and headed out into the world for job interviews. Several also stated they were grateful for the experience of doing "real" research to prepare them for the possibility of graduate school. In fact, two students presented their Math 490 research papers at a professional conference after the course was over (one of them winning a research prize of $500). All of the Math 490 students felt the experience was enjoyable and worth their effort – so much so that they volunteered to repeat their presentations at a local Community College the following semester.

Second, the Mathematics Education majors who served as greeters, guides, and room monitors reported satisfaction with the opportunity to meet each other. These students seldom identify peers in their major until they are accepted into the Dept. of Education Program with Junior standing. By giving them an identifying name badge, coordinating their responsibilities, and having them stay for a half hour after Math Fun Day was over to eat together, they were able to make connections and form a cohesive support group that positively influenced their entire experience at UMES.

Third, faculty who gave presentations reported that they enjoyed the chance to interact informally with students. They liked being able to share their expertise in a fun way, to eat and "play" with students, and felt that Math Fun Day was a good public relations tool for the Math Dept. The faculty advisor to the Math and Computer Science Club shared that several students joined the Club after seeing their robotics demonstration. The only regret was that more of the Math Dept. faculty did not choose to participate in any way.

The last issue to consider is the effect of organizing Math Fun Day on the few faculty who did participate. Most of the responsibility fell on the Math 490 instructor.Sheperformed the usual teaching duties, including helping students learn to do research and use PowerPoint. But beyond this course load, she had toschedule, advertise, organize, and supervise Math Fun Day. Room space on campus had to be reserved, including requests for technology. She purchased refreshments, supplies, and honorariums,then submitted requests for reimbursement. Shecontactedall Math Ed majors about the event and coordinated their responsibilities. She prepared and printed signage, name badges, and attendance sheets and then distributed attendance to instructors after the event. Two other faculty helped by serving refreshments at Math Fun Day, but a large commitment of time and energy was required of this one individual.

CONCLUSION

In order to close the achievement gap in mathematics for minority students, research suggestsproviding students with extracurricular activities where they are given opportunities to talk about math and develop social support networks. Schools and colleges have risen to this challenge by providing a variety of programs and events.Likewise, UMES (a HBCU) designed a Math Fun Daywith hopes of changing minority students' attitudes about math. During the event, participants were engaged in worthwhile mathematics tasksthat helped them recognize the math in the world around them, and they spent considerable time talking to each other about those tasks. Younger students interacted withcompetentrole models and Math Fun Day provided a vehicle for developing support networks that may have encouraged freshman to take upper-level math classes. The consensus from all those involved was that math is fun!

Although Math Fun Day was abandoned last year due to the lack of math majors ready for graduation and Math 490, there are plans to reinstate the event in 2014 -2015. The Math and Computer Science Club would like to use the event to recruit members, and the Math Dept. is weighing its value against the required time and energy commitment.

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