

## Using Problem-Based Learning (PBL) to Address the Needs of Teaching and Learning Mathematics for Students in the Non-dominant Cultures of our Society

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**Abstract:** With the introduction of Principles and Standards for School Mathematics (NCTM 2000) in April 2000 at the 78<sup>th</sup> Annual Conference of the National Council of Teachers of Mathematics (NCTM), educators around the world, and specifically in the United States, once again reaffirmed the importance of investigating ways to improve mathematics education for all children. I share here work that began with a number of educators from the North Central (USA) Benjamin Banneker Association who used problem-based learning as a relatively new paradigm for informing classroom operations to define and overcome social barriers in the mathematics classroom for African American students. The conceptual basis for this paper began there but continued to include experiences at the 2001 annual conferences of the NCTM and the National Council of Supervisors of Mathematics (NCSM). This presentation broadens the context to include other representations for diversity.

**Introduction** *“I can’t teach them. They don’t want to learn!”*, *“The students in this country are nothing like the students in my home country.”*, *“Well, if their parents valued an education maybe I could teach them!”*

The statements above provide a sample of the kinds of statements sometimes voiced by educators who do not really know their students in large part because they are in some ways different from them. On any given day perhaps any of us might be guilty of making such generalizations. However, when these statements become a part of the norm for us, we are in danger of adjusting our expectations and subsequently limiting the learning opportunities we provide for our students. As our teaching actions begin to accommodate such thinking we become contributors to the world-wide problem of lack of equity in opportunity and learning outcomes for students—particularly those representing the non-dominant cultures of our society. Although we are reminded that “...all students, regardless of their personal characteristics, backgrounds, or physical challenges, must have opportunities to study—and support to learn—mathematics” (NCTM 2000, p. 12) it is clear that this goal has not yet been achieved. This lack of equity, especially as it affects the students in the non-dominant cultures of our society and their learning of mathematics, sets the stage for the concerns dealt with in this paper. My goal is to encourage the use of problem-based learning (PBL) to support efficacious actions by preservice and inservice teachers to address the problem of equity disparity in their classrooms. More specifically, I will share my PBL experiences, which began in Chicago, and continued to Orlando, Florida, before I returned home to Ohio.

Traditional researchers have engaged in numerous approaches to better understand and properly educate students of the non-dominant cultures of our society. Strong relationships between equity disparity and such quantifiable factors as socioeconomic status, race/ethnicity, and linguistic diversity have been identified (Campbell & Silver, 1999; Perie, Sherman, Phillips, & Riggan, 2000). However, these factors have not yet led to any definitive approaches for either explaining or addressing the disparity in student outcomes in mathematics. “It doesn’t add up...” (Gloria Ladson-Billings, 1997, p. 697), so we must continue to look elsewhere. Many policy-makers and educators believe that the inequities are situated in conflicts in the learning process which occur because of the likely mismatch between what is socio-culturally natural for students and what is socio-culturally natural for teachers (Delpit, 1988; Malloy & Malloy, 1998).

I am recommending PBL as a vehicle for dealing with the possible mismatch because it offers both a cognitive and a collaborative approach to solving a rich, realistic problem that “affords free inquiry by students” (Evensen & Hmelo, 2000, p. 2). Student-centered learning, a second, but equally important, factor of the PBL approach permits the students (teachers, in this case) to “decide what they need to know to find success...[as they] gradually take responsibility for their own learning” (Glasgow, 1997, p.

34). There is considerable freedom in the PBL process, however there are some basic characteristics that should be present. These basic characteristics are identified in the historical roots of PBL. These roots sometimes refer to John Dewey's project-based, problem-solving learning, but are more inclined to make connections to the modern-day use of PBL based upon the work of Howard Barrows, physician and medical educator, at McMaster University in Hamilton, Ontario, Canada (Barrows & Tamblyn, 1980; Delisle, 1997; Frederiksen, 1999; Evensen & Hmelo, 2000; Glasgow, 1997; Januszewski, 1999; Roschelle, 1999; Savin-Baden, 2000). Although the characteristics or phases of the PBL process may be summarized differently (Edens, 2000; Evensen & Hmelo, 2000; Frederiksen, 1999; Savin-Baden, 2000), I will refer to the essential characteristics of the PBL process and the phases implemented in the PBL tutorial (Barrows, 1988) as I share my personal experiences with the approach.

For some educators PBL represents a curriculum. I am more interested in the application of PBL as a process—a process that has the potential to leave the learner “knowing the world differently...taking a stance towards re-evaluating their current views and perspectives” (Savin-Baden, 2000, pp. 72-73). I believe that the preservice teacher or inservice teacher who engages in a PBL exercise—whether formally or informally—will be able to realize that it is a natural phenomenon for humans to observe, look for patterns, and generalize about others. However, this observation often serves as one of the major sources of problems that teachers have in truly communicating with their students of the non-dominant cultures. Consequently, the teacher engaged in PBL to find a solution to this problem should become enlightened to know that all observations must be seen through a critical, discerning, perhaps ethnographic eye (Frank, 1999). I believe that engagement in a PBL process can convince teachers that there is more to students than that first impression we get when we make judgments about them from a perspective that is grounded solely in our own personal experience.

The “PBL process is cyclical” (Edens, 2000, p. 56) and has at least three phases: problem development (introductions and climate setting); working on the problem (initiation of PBL events, inquiry, and investigation); and problem solution (problem follow-up and post-problem reflection).

### **Phase 1: Problem Development**

PBL Characteristic #1: Interested Parties Meet to Discuss a Problem

Anthony Scott, doctoral student, Chicago school principal, and president of the North Central Benjamin Banneker Association (an affiliate of the National Council of Teachers of Mathematics) published the January 2001 issue of the Griot, the newsletter of the region. The Griot announced the focus for the regional conference, scheduled for March 31, 2001, in Chicago, Illinois. All members and interested parties were invited to attend to engage in PBL to “deal with research issues concerning the proper education of African American students” (Scott, 2001, p. 1). As suggested by Barrows (1988), the teachers attending the conference were given informal time to get to know each other. After informal introductions and conversations during a continental breakfast, the formal portion of the conference began. Scott introduced others who would join him in various leadership roles for the day (Drs. Dorothy S. Strong, Marie D. Jernigan, Gwen Long, and Robert Sadler). Afterwards, the attendees introduced themselves. Each person briefly identified personal background information that might be pertinent for the day's proceedings. This information allowed “facilitators and each other to understand what expertise might potentially be distributed in the group” (Evensen & Hmelo, 2000, p. 2). Mike Turner and Sherrie Morrison, mathematics teachers from Miami University's inner-city partner schools in Cincinnati and Hamilton, Ohio, respectively, attended the conference with me so we could continue the PBL experience upon return home. Cincinnati is 35 miles and Hamilton is 15 miles from Oxford, Ohio—the site of Miami University's main campus.

In accordance with the first phase of the PBL process, Jernigan, the lead facilitator for the day, helped us establish some overall ground rules for operations. These ground rules would support nonjudgmental participation and feedback to “...establish a comfortable climate for collaborative learning”

(Evensen & Hmelo, 2000, p. 2).

## **Phase 2: Working on the Problem**

### **PBL Characteristic #2: Using a Real-World Context Emphasizes the Reality of the Problem Situation**

Jernigan gave initial information about the problem as suggested by Barrows (1988). We were reminded of the problem for the day: To develop a set of recommendations for ways to effectively work with African American students. Next we were shown a 5-minute movie clip of the American movie, “Sister Act II,” to give us common ground for initiating our efforts on the problem. This movie clip featured Whoopi Goldberg as a new teacher coming to an out-of-control music class on the first day. We were asked two questions: What do you think of those children? What would you do as the new teacher? Jernigan helped us clarify the problem in the context of teaching mathematics to African American students. According to Barrows (1988), the group’s task in this phase was to evaluate and identify different aspects of the problem and gain insight into underlying issues. Consequently, we were assigned to three subgroups of approximately seven people each to work on various aspects of the problem— instruction, curriculum, and assessment. I was assigned to the curriculum group, led by Scott. Long and Jernigan facilitated the instruction and assessment groups, respectively.

As Scott took on the role of facilitator in our small group, we moved to a separate table to work. A teacher from the group volunteered to serve as scribe. Using easel paper perched on the tabletop so all members of the group could see, the scribe operated in accordance with the suggested roles (Barrows, 1988) as the group members provided input: What do we already know? What else do we need to know?

### **PBL Characteristic #3: Work with the Problem in Ways that Engage Each Member’s Ability to Reason and Apply Knowledge**

We began our discussion about the teaching/learning situation in the video clip. As we responded to the initial questions asked, we each had our opinions about the possible course of action the teacher should take to work effectively with the students who represent the non-dominant culture in a given society. A member of the group declared,

“Everything we’ve said represents knowledge that comes with experience—years of experience...and some of it comes from what is in our backgrounds.”

Another member followed with, “So, the teacher needs to know a technique or several techniques. The use of trial-and-error [in determining the techniques] will be dependent on the teacher’s background.”

Another member posited, “Remember, you’re a role model [in the classroom for the students; they will respond in ways congruent to the teacher’s approach]. Whom in your background will you emulate? If you haven’t seen good teaching, it will be difficult for you to do.”

Another comment hit closer to home for me, “We aren’t given college classes to help us teach in different cultures.... First, the teacher needs to do something to survive.”

The facilitator led us to pause and reflect as he suggested that it might be helpful to make an itemized list of what we know, then group members could identify areas they wish to investigate more closely: both to validate what we believe we know and to find additional information that will help us solve the problem. The following is a summarized list of what the group identified:

1. African American students (as well as other students representing non-dominant cultures) tend to learn holistically. If there is a lack of continuity and connections in planning lessons, students need to know where the day-to-day lessons are heading.
2. Teaching should be relevant to the lives of the students. The teacher must assist students in making deliberate connections.
3. Learning must be engaging (active). High expectations and higher-level thinking questions must be infused throughout instruction.

4. There is little, if any, consistency in methods of classroom instruction from year to year (or from class-to-class. Students need assistance in determining the socio-cultural rules for each new scenario).
5. New teachers need mentoring. (They need someone to assist them in looking at their classrooms with a discerning eye and getting to know their students.)
6. Many African American students are motivated to perform based upon their personal connections with the teacher.

Questions:

1. How can you deliver instruction if you can not get classroom control?
2. How do you incorporate the needs of the child with the mandates from the culture? Learning styles?
3. How does the teachers' culture affect students' learning?
4. Are there any proven methods to assist in these efforts?
5. How do we make a learning community?
6. How can we teach children to be powerful learners?
7. How can we help children actively value education—noting there is a difference in schooling (i.e., training to follow set rules) and education (i.e., empowering to learn).
8. How do we implement instructional strategies to create an atmosphere of positive peer pressure for educational goals?

**PBL Characteristic #4: Areas that Require Further Investigation are Identified and Individual Members Engage in Study to Investigate Their Part of the Problem**

Each member of the group identified a “known fact” or question to investigate further. Some members went to the computer lab to search the Internet. Some consulted the library of materials that had been provided in the back of the meeting room. Others consulted the many articles in the packet given to them upon arrival at the meeting. Each member worked to bring information back to the group that could be validated as it might be offered to help to solve the problem.

**Phase 3 – Problem Solution**

**PBL Characteristic #5: Evaluate the Work Done by Individuals and Reapply the Skills and Knowledge Previously Used to Determine What Learning Has Taken Place**

The group members reconvened for a working lunch “...to share what they have learned, to reconsider their hypotheses, or to generate new hypotheses in light of their new learning” (Evensen & Hmelo, 2000, p. 3). As we prepared to report to the larger group, it was important to determine what possible solutions we might have acquired during the individual study process. We discovered that our research efforts had taken us somewhat away from curriculum and included more issues regarding instruction and instructional approaches. We were comfortable with the change in focus because we decided these issues might be the first lines of defense for the proper education of African American students. We agreed that teachers must engage in experiences to really know their students in order to determine the approaches that might work best for any given group of students.

**PBL Characteristics #6: Summarize What Learning Has Taken Place and Individually Integrate That Learning into One's Own Knowledge and Skills Base for Future Use**

Jernigan facilitated as the small groups reported their findings to the larger group. Although “the emphasis in PBL is not necessarily on having students solve the problem” (Evensen & Hmelo, 2000, p. 3), we were eager to have an initial solution to share with others. We wanted to provide a list of recommendations that support teachers of African American students as they facilitate their learning of mathematics. We are continuing to work on this process; however, a few of the recommendations we discovered are as follows:

1. “Teachers should use all modes (visual, auditory, tactile, and kinesthetic) when teaching concepts and skills” (Heredia, 1999, p. 5).
2. Affective dimensions and interpersonal skills are key components. Many African American students ignite or sustain their motivation to learn based upon the human element—the teacher.
3. High expectations are essential. “. . .When teachers believe in students’ abilities, the students are likely to be successful” (Ladson-Billings, 1997, p. 703).

### **Continuing the PBL Process**

Although this meeting came to a close, as PBL learners intent on finding more information about the problem, many of us continued onward the next day to gather information at the annual meeting of the National Council of Supervisors of Mathematics (NCSM) in Orlando, Florida. For me, the problem also took on the added notion of identifying how to help preservice and inservice teachers engage in a similar learning process to find their own ways to appropriately educate their students of the non-dominant cultures.

In one of the first NCSM conference sessions I attended in the focus area of ethnomathematics, the audience was reminded that the level of diversity in our current society has reached heights and complexity never before reached. I had not realized the impact of that truth before. In the past, I wondered why more teachers were not simply able to begin work with a group of students who were different from them and still manage to be more effective. Now, as I understood that many of these teachers were going through uncharted territory as they work in an environment very different from their own youth, I also realized the necessary knowledge and skills had to be taught. Yet, I couldn’t imagine a class for preservice teachers at the university or a professional development workshop for inservice teachers that would do more than engage its learners in an academic exercise that eventually would not lead them to any changes in their day-to-day interactions with their students. This realization suggested the power of PBL to make a difference.

As Jim Barta (Utah Sate University), Rick Silverman (University of Northern Colorado), and Gloria Gilmer (Math-Tech, Milwaukee, Wisconsin) led the audience in the first ethnomathematics session in the NCSM conference we shared our own personal cultural narratives for significant moments in our lives, the issue of equity in the classroom became clearer. Even those of us who look quite similar, or who grew up in the same town, have certain fundamental socio-cultural differences that form the basis for all of our interactions. If this is true of those of us who think we come from the same socio-cultural background, then how much more so must this be true for those of us who come from distinctly different socio-cultural backgrounds? At the very least teachers have an age difference with their students. In the USA, many students representing non-dominant cultures in our society are also likely to have a teacher who represents a different culture. If teachers are inclined to teach to their preferred learning style, which may be different from those of their students, then steps should be taken to more closely align instructional strategies with the needs of the students (Bennett, 1995).

**Conclusion** So where do we go from here? The person who must play the major role in changing the occurrence of inequity for students from non-dominant cultures is the classroom teacher. Classroom teachers must examine the school practices and their own practices in the classroom to make sure an environment conducive to learning for all is being developed. Efficacious teachers have been identified as key factors in an effective school (Cotton 2001). As teachers take responsibility for their students’ learning, they can be encouraged to engage in research that helps them to know what their students know, believe, and live. The individual teacher must become the change agent and engage in periodic investigation and reflection to define goals for teaching and professional development (NCTM, 1991; Stanley, 2000). Engaging in a PBL process can support investigation of data and published resources to

discover ways to meet the needs of all students. As teachers filter their learning through an ethnographic perspective to make the appropriate adaptations in their classroom, problems with equity can be addressed. Thus, I submit that PBL engaged in formally or informally is the way to assist the teacher in taking on this role and making a difference in the mathematics education for all students—and especially for students from the non-dominant cultures of our society.

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