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African American Children and Mathematical Problem Solving in Texas
An Analysis of Meaning Making in Review

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ABSTRACT

The purpose of this report is twofold. First, this report describes African American students' approach to making meaning of mathematical problem solving. Second, this paper describes my use of a graphic organizer to develop the mathematical problem solving skills of African American high school students in Texas. I center these aims on three concepts. First, I describe the interrelation of culture, meaning making, and mathematical problem solving. Next, I explain the theoretical concepts that are related to developing the mathematical meaning making skills of African American students. I then discuss recent empirical studies regarding the mathematical problem solving skills of African American students. The findings from these studies and my research warrant several implications for improving the problem solving skills of African American students. The most important implication is to allow African American students to use their cultural norms for learning to make meaning of their mathematical problem solving experiences.

Introduction

Mathematical problem solving is one of the most central aspects of mathematics (Flavell, 1976; Kilpatrick, Swafford, & Findell, 2001; Swartz & Parks, 1994). O'Connell (2000) posited that problem solving helps students make sense of how mathematics can be used in daily situations. Much research has investigated students' mathematical problem solving behavior (Garofalo & Lester, 1985; Grouws & Cebulla, 2000; Montague, 1992; Verschaffel, 1999). But few research studies have focused on the problem solving skills of African American children (Malloy & Jones, 1998; Moyo; 2004). This report examines the discourse regarding African American children's ability to make meaning of and solve mathematical word problems. The report also describes strategies for developing African American students' ability to solve mathematical word problems.

The rationale for this report is the focus on meaning making and problem solving- two under researched aspects of African American students' mathematical experiences. Researchers have indicated that many African American children struggle with mastering mathematics (Fryer & Levitt, 2006). They attribute these deficiencies to poor parental support for and a poor attitude towards mathematics. In response, Black scholars have developed the Algebra Project (Moses & Cobb, 2002) and other interventions to address these deficiencies. This report redefines the issue by discussing the role of meaning making and problem solving in building African American success in math classrooms.

This report is organized into six sections. The first section discusses the relationship between mathematical problem solving and mathematical meaning making. Another dimension is the factors that influence students' abilities to make meaning of mathematical word problems. The second section describes how making meaning of mathematical word problems is related to Lev Vygotsky's (1978) sociocultural theory and Murrell's (2002) African Pedagogy Theory. In the third section, I use the information from the first two sections to theorize why many African American children experience problems with making meaning of mathematical word problems. The fourth section provides a brief summary of research regarding African American children and mathematical problem solving. In the fifth section, I describe my personal success with developing 12 underachieving African American high school children's mathematical problem solving skills. In the sixth and final section, I offer recommendations for using this report to develop African American children's mathematical problem solving skills.

Mathematical Problem Solving & Mathematical Meaning Making

Mathematical problem solving has been defined as the ability to read, process, and solve mathematical situations (Goldberg, 2003). Most mathematical problem solving situations are relegated to imitation of procedures. Teachers introduce the word problem to students, and then provide them with linear steps to solving the problems. The students are then expected to use these steps to develop a solution for the math problem. However, this process often fails to provide students with the ability to develop personal representation and understanding mathematical problem solving. In other words, students have not received the opportunity to make personal meaning of mathematical word problem situations.

Mathematical meaning making is the ability to personally construct meaning of mathematical experiences. O'Connell (2000) reported that students must enter a mathematical meaning making space to solve mathematical word problems. For minority students, the entry into this space is mediated by four variables: culture, choice, attitude, and previous mathematical experiences.

Culture affects this space because of mediating the words of the mathematical word problem (Smagorinsky, 2001). For example, suppose a group of sixth grade students are given the following sixth grade word problem:

> *Two ponies and three elephants are racing through a jungle. The ponies' speed is twice as fast as the elephants' speed. If the ponies are running at a speed of 20 miles an hour, what is the elephants' speed?*

Many teachers would assume that sixth grade students have the cognitive skills to solve this word problem. However, the students' cognition will be influenced by the students' cultural experiences with ponies and elephants. Some students may not have any cultural experiences with or connections to these animals. Consequently, they would be less likely to process the purpose of the word problem than students who have had meaningful cultural experiences with these animals. In addition, they may be unable to develop the meaning making resources needed to solve the word problem.

The other students would presumably have the cultural experiences to make meaning of and solve the word problem. But their choice is to avoid the meaning making space. In effect, the problem may have little or no meaning to the students. Another reason is that they may be more consumed with life events than solving a mathematical word problem about ponies and elephants.

As another example, previous math experiences influence students' decision to enter the meaning making space for mathematical word problems (Martin, 2000). Schoenfield (1989) argued that students' previous math experiences are defined by the culture of the mathematics classroom. This culture is comprised of an emphasis on either memorization or internalization. Memorization requires students to recall a predetermined set of steps and procedures to make sense of their mathematical experiences.

As a result, students thrive on teacher questions such as "Are there any questions?" and "Do you understand?" The reason is that this inquiry creates opportunities for students to place all of the meaning making responsibilities on the teacher. In response, the teacher models and explains the math concepts until the students "get it" (Smagorinsky, 2001). Internalization provides students with opportunities to understand the relationship between meaning making and success in math. In this context, students receive experiences on data collection, data representation, and pattern investigation. This approach also expands students' use of these skills to make meaning of their mathematical experiences.

Thus, if students are trained to excel in math through memorization, they will be unable to make meaning of mathematical word problems. They are more likely process practices than practice the process of inquiry, exploration, and investigation. In addition, their procedural orientation could prevent them from initially succeeding in math classrooms that promote understanding.

The other significant variable is attitude. Kilpatrick, Swafford, and Findell (2001) stated that students' attitude about mathematics can be investigated through the following question:

> Does the student view mathematics as the ability to construct personal meaning of numerical equations and symbols?

An affirmative response indicates that the student's attitude is tangential to the meaning making significance of the mathematical problem solving space.

Overall, the interrelations of these variables determine the mathematical meaning making behavior of students. In essence, students must choose to use their written and verbal skills to enter the mathematical meaning making space. This decision is highly affected by students' attitudes towards math. Their attitude towards math is an outgrowth of their previous math experiences. This assertion is supported by empirical findings on the correlation between mathematical attitudes and previous mathematical experiences (Mayer, 2003). Another important variable is the cultural background of the students. As indicated, students' cultural experiences help them to make sense of the world-a world that influences the culture of a mathematics classroom.

Theoretical Concepts

Vygotsky's Sociocultural Theory

Lev Vygotsky (1978) defined learning as the use of social and cultural order to grasp the meaning of information. He believed that knowledge acquisition is mediated through interaction with other people. In other words, students learn best whey they interact with their classmates and teachers.

His theory rests on two notions. First, learning is achieved through cultural tools and signs. Cultural tools are objects that assist students with accomplishing goals. Cultural signs are symbols that represent significant meaning to people. They evoke previous thoughts, ideas, and feelings.

The second underpinning of Vygostky's (1978) theory is language. Language is a cultural signal and tool that communicates speech. Language provides a framework for using external speech and internal speech to make meaning of situations. External speech guides children towards making good decisions. Internal speech is the automatic independent use of speech to engage in effective decision making. Both of these tenets are applicable to instruction.

In essence, math teachers model external speech by providing students with instruction. They guide students on how to work through mathematical problems. As students experience this talk aloud experience, they transfer verbal instruction into internal speech. An example of internal speech is the self-directed organization of teacher instruction into problem solving behavior. This transition epitomizes Vygotsky's (1978) ultimate goal of self-regulatory achievement. Specifically, students become self-regulated individuals by using behavior-defining cultural signs and tools.

The third tenet is Vyzotsky's (1978) Zone or Proximal Development. This concept purports that learning is the space of potential development between the learner's current knowledge and the knowledge development from guided assistance. Teachers bridge the gap between these points by guiding the learner to a higher level of understanding. Specifically, they scaffold instruction, create prompts for reflection, and develop other meaning making activities. The underpinning of this framework is co-participatory learning. Better stated, students participate in the guided practice to grasp information.

Murrell's African Pedagogy Theory

Vygotsky's (1978) theory provides a sociocultural lens for developing strategies to enhance African American children's mathematical problem solving skills. His theory promotes the African pedagogical theory needed to understand African American culture's place in the math classroom. Murrell's (2002) African Pedagogy Theory focuses on a teaching-learning relationship that minimizes the political and hegemonic barriers to African American students' achievement. This theory purports that effective instruction is comprised of three interrelated themes: the teacher, the student, and the activity. Teachers involve African American children in this relationship by becoming familiar with African American culture. They are required to use this familiarity to design an appropriate learning environment for these students. In addition, African American students are able to learn from the teacher, students, and classroom activities. As a result, teachers, African American students, and the learning activities become a joint pursuit of academic achievement.

This theory and Vygotsky's (1978) theory both emphasize a sociocultural relationship between students, teachers, and the learning environment. They acknowledge that learning is situated in the social context of interacting with other people. Finally, both theories support the notion of the relationship between student achievement and the culturally mediated learning experiences.

Both theories drive the development of this report. They denote socialization's potential impact on African American students' abilities to make meaning of and solve mathematical word problems. In other words, a discussion of mathematical meaning making and African American children's problem solving behavior should be centered on the current cultural practices of the classroom.

African American Students and Mathematical Problem Solving

Like other children, African American students quickly learn the culture of the classroom. They also quickly adjust to the teacher's educational mannerisms and beliefs (Murrell, 2002). Thus, African American children's academic behavior is an outgrowth of the culture of the classroom. Research has indicated that African American children receive poor mathematical experiences in schools (Delpit, 1995, 2003; Ogbu, 1992). They are also more likely to learn mathematics from noncertified teachers than any other group of students (Darling-Hammond, 2000; Darling-Hammond, Berry, & Thoreson, A. 2001). Their teachers are also more likely to hold lower expectations for them than for other groups of students. In due regard, most of their mathematical experiences are developed in classrooms that counter Vygotsky's (1978) theory and Murrell's (2002) African Pedagogy Theory.

Evidence to this effect can be seen in high teacher emphasis on memorizing math facts and procedures. As a result, many African American students begin to equate mathematical thinking with the completion of worksheets. They may rarely receive authentic experiences on using meaning making to solve mathematical word problems. As they matriculate through school, these students are less likely to use meaning making to explore and solve math word problems. In the traditional realm, they would presumably validate their mathematical problem solving by practicing word problem procedures in textbooks.

Empirical Research

Two significant studies have defined the discourse regarding African American children's mathematical problem solving behavior. Malloy and Jones (1998) investigated the meaning making skills of 24 eighth grade African American students. They used talk aloud sessions to observe the students' strategy selection use and verification skills. Their research revealed several significant findings.

Consistent with African American cultural norms, they applied a holistic approach to problem solving. Successful students excelled at using this approach to navigate the orientation, organization, execution, and verification steps of problem solving. They also reworked these strategy selections until reaching a final solution.

Unsuccessful students did not adjust their problem solving behaviors. But they did use a variety of strategic pathways to reach an appropriate solution. A significant aspect of these findings is that the students were high math achievers. They also were enrolled in pre-collegiate math enrichment programs.

Moyo (2004) studied the use of graphic organizers to develop eight ninth grade African American students' problem solving skills. She developed a Kuringa paper (Swahili for "Show Off") to assist them in mathematical meaning making. She studied the students' use of the graphic organizer through surveys, audio recorded transcriptions, and semi-structured interviews. She found that several obstacles influenced the students' use of the Kuringa paper. They were previous math histories, poor math histories, and reliance on memorized math skills.

The students' success with the graphic organizer was related to assistance from Moyo (2004). Overall, the students used the "representation" section of the Kuringa paper to make meaning of problem solving. Based on his findings, Moyo concluded that graphic organizers should become an organizational tool and normative practice in mathematical classrooms. The following “Kupanga Project” section describes my use of Moyo’s (2004) and Malloy and Jones’ (1998) research to develop underachieving African American secondary students’ mathematical problem solving skills.

The Kupanga Project

Research Design

I used a qualitative case study research design to conduct the Kupanga Project (Merriam, 1998). A case study is used to provide in-depth detail about units of analysis such as programs, events, and individuals. Following this design, I used a questionnaire, observations, and test results to gain in-depth detail about African American students’ meaning making approaches to mathematical problem solving. I also used this data supply to determine how graphic organizers impacted the students’ meaning making paths to problem solving solutions.

The Program Initiative

In the spring of 2007, I developed a 12-week program to improve the mathematical problem solving skills of 12 underachieving African American high school students. The group consisted of give boys and seven girls. They attended a predominantly African American high school in Houston, Texas.

The students were chosen from three classrooms. Their teachers nominated them for the program because of their low grades in mathematics. In addition, the students were indifferent toward mathematics. Whereas most of the students excelled in mathematical computation, all of them struggled with solving mathematical word problems. Two boys were identified as being behavior problems.

The significance of this population lies in the research on underachieving students. Deci and Ryan (1985) theorized that underachieving students have the same intellectual ability as high achieving students. They just fail to display the interest in and motivation to becoming achievers. In some instances, these students can be extrinsically motivated to pursue achievement.

Like Malloy and Jones’ (1998) and Moyo’s (2004) students, the students in my Kupanga project are capable learners of mathematics. Unlike the other students, the Kupanga project students have chosen not to achieve to their mathematical potential. An external influence, I sought to use a learning tool to facilitate the students’ fulfillment of mathematical problem solving potential.

I used two strategies to accomplish this goal. First, I administered a pretest (Appendix A) to the students to analyze their mathematical problem solving skills. I used the results to tailor the Kupanga paper’s (Appendix B) use to the skills of the students. The “Kupanga” paper was specifically designed to help the students with making meaning of and solving mathematical word problems. I use “Kupanga” to define the project and paper, because this term is Swahili for “Organization”. In addition, the major focus of the “Kupanga” paper and program was an organized approach to mathematical word problems.

The “Kupanga Paper” is comprised of four components and six steps. The components are Sequentialization, Picturization, Calculation, and Validation. Listed below is a description of components and steps.

1. Sequentialization-Sequentializing the essential elements of the paper. This step helps children to identify the key elements needed to solve the word problem.

Sequentialization Steps:

A. Identify and write the sentence that describes the overall purpose of the word problem.
B. Identify and write the sentences that describe the facts of the word problem.
C. Identify and write the sentences that describe the information needed to solve the word problem.

2. Picturization-Use of words and symbols to transform essential elements into the “Big Picture” for solving word problems. At this stage, the students are expected to create a visual representation of the problem. Representations include drawings, sketches, diagrams, graphs, and equations. This section shows how the student translated words into visual meaning.

Picturization Step:

A. Transform the third sequentialization step into a visual representation of the problem.

3. Calculation-The use of computational math skills and critical thinking skills to find the solution to the math problem. This step provides students with the opportunity to solve the word problem.

Calculation Step:

A. Use the picturization step and first and third sequentialization steps to develop a computational strategy for solving the word problem.

4. Validation-The use of reflective thinking to support the solution to the word problem. In particular, students are required to justify the picturizations and calculations of the word problem.

Validation Step:

A. Use the previous components and steps to write a rationale that supports the solution to the problem.

These steps provide students with a concrete approach to organizing their steps for mathematical problem solving. Students also become more skilled at documenting and analyzing the thought process of their organization. To support this developmental transition, I inform teachers to replace “Show your Work” with “Show your organization.”

I used the latter phrase as the motto for the program. During the first three weeks of the program, I explained and modeled the use of the “Kupanga” paper. After modeling the use of the paper, the students used the tool to solve word problems that reflected the NCTM’s (2000) goals on mathematical problem solving. I then used the Kupanga paper to engage the students in discussion on the sequentialization, picturization, calcucation, and validation of their answers. For the remaining nine weeks, I did not explain the use of the “Kupanga” paper. Instead, I provided the students with one mathematical word problem (Appendix B). The word problems were modeled after sample word problems from the Texas Education Association website.

During the first 45 minutes of the remaining sessions, the students independently used the “Kupanga” paper to solve the word problem. While working on the word problem, they used a tape recorder to describe their use of each “Kupanga” paper step. During the remaining 45 minutes of the session, the students worked in 4-member groups to discuss their approaches to solving the word problem. The following norms were used to govern individual and group work:

1. No grades or rules were given to students.
2. Students were not given roles in their groups. They were directed to discuss their use of the Kupanga paper to make sense of and solve the word problem.
3. Students could move freely in the classroom.
4. Students were required to use the Kupanga paper to solve the word problems.
5. Students were encouraged to share their ideas, thoughts, and solutions to their word problems.

I used these norms to provide the students with a natural, stress-free environment for solving the word problems. The structure would increase the probability of the students sharing their ideas and feelings about the word problems and solutions.

I strengthened these norms by serving as a facilitator of the sessions. Consistent with Vygotsky’s (1978) Zone of Proximal Development theory, I scaffolded instruction and created prompts for reflection. I sometimes refocused their attention on the purpose of the Kupanga paper and word problems.

Results

Observational Results

During the first four sessions, the students struggled with using the Kupanga paper and other resources to master the word problems. In addition, many students did not believe in their ability to be effective mathematical problem solvers. One student, in particular, would continuously say, “You have to be a born problem solver in math.” Other students expressed hopelessness by making the following statements:

"This is too hard! I just can't do it!"

"I can't do this. This is way out of my league!"

"I can't understand this problem!"

However, I did not explain the problems for the students. Instead, I used probing questions and other Socratic methods of teaching to redirect their attention to the word problems. I also used these techniques to help them understand the Kupanga paper's role in developing their problem solving skills.

The purpose of this approach was twofold. First, I didn't want to assume the pedantic role of just explaining the problem and solution to the students. Instead, I wanted them to use their knowledge and skills to make personal meaning of the word problems and Kupanga paper. Second, I wanted to see if the students either didn't understand the word problems or CHOSE not to understand the word problems. In many instances, the students chose not to understand the word problems. As a result, I continued to redirect their meaning making skills for using the Kupanga paper and think aloud protocols to solve the word problems.

Consequently, the students approached the remaining sessions with more confidence for solving the word problems. I observed that they began to focus more on how to use the Kupanga Paper, think aloud protocols, and group sessions to solve the word problems. They began to only solicit my assistance in understanding some of word problem vocabulary words. I also noticed that the students were able to organize their thoughts and ideas on solving the word problems. Some students would write their ideas on a blank piece of paper. Using the think aloud protocol, they would read and organize their thoughts onto the Kupanga paper. They would then talk themselves through the calculation and validation procedures. Other students used the group sessions to organize their thoughts onto the Kupanga paper. They would then use the think aloud protocol to make final decisions on how to solve the word problems.

Test Results

At the end of the program, I administered an 8-item word problem exam (Appendix C) to the students. Ten of the students correctly solved at or over 80% of the word problems. The remaining two students correctly solved less than 50% of the word problems. The ten students missed their word problems because of making careless errors. The other two students missed half of the word problems because they were unable to connect the picturization component to the calculation components of the Kupanga paper. Overall, all of the students used the Kupanga paper to solve every word problem. This result highlighted their growth in using a graphic organizer to create solutions to solving the word problems.

Survey Results

At the end of the program, I administered a questionnaire to the students. The questionnaire was designed to determine the Kupanga program's effect on their mathematical problem solving skills. The following protocol was used to elicit this information: “Provide a written description of how this program affected you.”

Three themes emerged from the written responses: The Kupanga paper, the tape recorded sessions (think aloud protocols), and group discussions.

Kupanga Paper. All of the students indicated that the Kupanga paper helped them with organizing their thoughts and ideas for solving word problems. One student wrote:

“Before this class, I would just write the steps for solving word problems. The Kupanga paper helped me to see that you don’t just write steps. You gotta be able to see how those steps tie into each other. You also gotta see that the steps must be organized to help you solve the word problems.

Another student explained:
“This Kupanga paper really helped me to see how to take my thoughts, put’em in a the right place, and then see how each of the places build on each other to solve the word problem.”

Another student wrote:
“The word problems didn’t see quite as hard once I got the hang of the Kupanga Paper. I think the reason is that each part of the Kupanga paper just helped me to study more on how to organize my ideas solving the problems. I was actually able to think through the way in which I should move from each step to get a good feel for solving the problem. I was also able to organize my thoughts on seeing better how and what the word problem wanted me to do.”

Think Aloud Protocols

The students believed that the audio recorded sessions allowed them to recognize their mistakes in solving some of the word problems. They used verbal feedback to better understand how each part of the Kupanga paper could be used to make meaning of the word problems.

For example, one student wrote:
“Sometimes, when we were in groups, I still didn’t understand why I missed a problem. But when I listened to my own voice on the tape recorder, I could hear where I went wrong. It just became automatic to me. It got to the point where I would play the tape, hear the mistake, and then go back and redo the mistake to get a better answer!”

Another student expressed:
“I think the tape recorder was such a cool idea. Word up! It just taught me to slow my roll and carefully read each sentence of the word problem. And to also look at how I am using each step to solve the word problems.”

Similarly, one student explained:
"I think that the tape recorder allowed me to hear myself talk to myself about the word problems. Not just to look a the steps for solving word problems, but to think about how to understand the ways in which the steps are to really be used to solve the word problems. Looking back, I think I was just so used to using what the teacher told me to do to attack math word problems. But using the tape recorder to record myself made me see I gotta keep thinking for myself about how to truly understand what the word problem is about. And then organize my thoughts to solve the word problems."

Other samples of students' thoughts about the think aloud protocols are:
"You know….when I used to work math problems, I didn't really think about what I was doing. But when I started to listen to myself and hear myself on what I said I was doing on the problem and on the Kupanga paper, I began to see what I was doing and how I was doing it."

"When you say the steps out loud, it's kind of like an "Out loud and proud" feeling. You get proud of being able to focus a little bit better on what you're doing on the word problems. But without hearing yourself speak, you can kinda get lost in the mix of problem solving-I know I did! So I just kept talking and talking into the tape recorder and playing the tape recorder because it helps me to really see what I should have been doing!"

Group Discussions

The students indicated that the group discussions helped them to realize the varied strategies and representations for solving mathematical word problems.

A student stated:
"All before, I was led to believe that the teachers give you the steps for mathematical problems solving. But now I see that me and my classmates can also be teachers for each other. I say that cuz my classmates' Kupanga papers and ideas help me to better understand how I could do what I needed to do to solve the word problems."

Another student described:
"Wow! Every time I worked in the group, I just saw some many different pictures of the word problems. And when I heard other students talk about the pictures, I was able to better understand my own picture and explanation for solving the word problems."
The students also reported that the group sessions helped them to develop higher order mathematical reasoning skills.

One of the most profound examples of this notion is as follows:
"Each week, I looked so forward to meeting in groups. I think the main reason is that I began to see how you can't just think critically like Ms. Berry (Pseudonym) always says. At some point, you've got to start thinking mathematically. You've got to really start

thinking with the math skills that you got and then use them to complete math problem. This kind of thinking is ever better when you look at how other people are thinking about solving the same word problem that you are doing."

Finally the group discussion built students' confidence for using the Kupanga paper to solve math problems:

A sample representation of this notion is:
"When I worked by myself, I was somewhat nervus about how to use the K paper. But as soon as I got into the group, I started to realize the other students were just as nervus as me. And the more me we began to vibe (Talk) about our fears and possible ways to solve the problems, The more I began to believe that I could use the K paper to understand how and what I had to do on the word problems."

Discussion

The outcomes of the Kupanga sessions create several points of discussion. First, consistent with Moyo's (2004) research, graphic organizers can be a significant cognitive and cultural mathematical problem solving tool for African American students. From a cognitive perspective, the Kupanga paper helped the students to use high levels of critical thinking to make sense of word problems. They were then able to use this meaning making to organize, calculate, and validate their solutions to the word problems.

In addition, the students used the think aloud sessions and group sessions to analyze their approaches to the word problems. These metacognitive experiences either validated or required them to revise their solutions. In short, they paid more attention to their approach towards mathematical word problem solving. This finding reinforces research on the use of metacognition to increase students' mathematical problem solving behaviors and the need to analyze thought processes used to solve word problems (Desoete, 2007; Flavell, 1976; Goldberg, 2003).

From a cultural perspective, I grounded the Kupanga paper in the following African American cultural practices: engagement, communalism, identity development, and inquiry (Murrell, 2002). In particular, the Kupanga paper facilitated students' use of these norms of African American community dialogue to make meaning of the word problems. The findings from the questionnaire showed their realization in how the exchange equipped them with more perspectives on problem solving strategies.

The metacognitive significance of this experience is that they thought more mathematically about how to solve word problems.

Overall, this interaction reinforces the National Council of Teachers of Mathematics' (2000) call for the construction of mathematical activities in the context of reciprocal discussion. This interaction also supports Vygotsky's (1978) belief in that "What a child can do with assistance to day, he will be able to do independently later" (p.32).

The second significant point is that African American students can become confident mathematical problem solvers. The confidence building is contingent upon the placement of the meaning making responsibility on the students. At the beginning of the Kupanga project, the students would consistently make statements such as, “Can you help me?”and “Would you please explain this problem to me?” These statements were indicative of their comfort with using direct instruction and teacher explanations to solve word problems. In other words, the teacher makes sense of the word problems for the students. This behavior supports the notion of how the culture of the mathematics classrooms defines students’ relationship with mathematics. (Schoenfield,1989). This culture also gives them their sense of mathematical identity (Schoenfield).

The results from the questionnaire suggested that the students’ previous mathematical experiences were centered on practicing specific steps with the construction of personal meaning. However, I did not respond to the students’ culturally influenced behavior with simple explanations. Instead, I challenged the students to use cognitive skills and the Kupanga paper to reexamine their mathematical behavior. Over time, the students developed the confidence to make personal meaning of the word problems and use the Kupanga paper to solve them. They just needed to remain in the meaning making space until they developed multiple pathways to the solution.

Recommendations and Conclusion

Mathematical problem solving provides students with a holistic perspective on the role of mathematics in daily situations (NCTM, 2000). This report analyzed the current mathematical problem solving skills of African American students. In particular, this report explained possible reasons for African American students’ difficulties with making meaning of mathematical word problems. This report also reviewed empirical studies on the problem solving behaviors of African American students. One study discussed specific strategies used to make meaning of word problems. The other study explored African American students’ use of graphic organizers to solve word problems. My Kupanga project investigated the applicability of both studies to underachieving African American students. In particular, I investigated underachieving African American students’ use of a graphic organizer to develop problem solving skills.

Due to the findings from those studies and my Kupanga project, I am making several recommendations. First, math teachers need to continually teach for mathematical understanding. My project and the literature show that when students are taught the meaning of understanding, they are more likely to make personal meaning of mathematics. Given the poor mathematical performance of some African American students, this outcome should be a major goal of all math teachers.

A second recommendation is to use sociocultural tools for mathematical problem solving. As indicated by the literature and my project, graphic organizers can enhance African American students’ success in problem solving. As a cultural tool, a graphic organizer can show African American students how to organize and validate their mathematical reasoning skills. Graphic organizers can also refer African American students back to the need for organizing these skills to solve word problems.

In addition, graphic organizers appeal to African American students' cultural appreciation of togetherness and dialogue. As evidenced by Vygotsky (1978) and the Kupanga project, African American students can use this tool to gain various perspectives on how to solve word problems. Equally important, these experiences a) provide students with a cultural connection to math; and b) enhance their mathematical thinking skills.

The final recommendation is for teachers to continually study African-American students' problem solving behavior. Research continues to show a wide disparity in the mathematical achievement between African American students and Caucasian American students (Fryer & Levitt, 2006, Jencks, 1998). Statewide standardized test results show that African American students earn significantly lower scores on mathematical problem solving than do Caucasian American students (Texas Education Association, 2007). Therefore, teachers should ask the following questions to guide their examination of African American students' mathematical problem solving behavior:

1. How does the cultural norms of African American culture influence African American students' interpretations of mathematical word problems?

2. How does culture, previous mathematical experiences, and student attitudes impact African American students' entry into the meaning making space for solving mathematical word problems?

3. To what extent are teachers willing to require African American students to rely on their own knowledge and disposition to make personal meaning of mathematical word problems?

4. How can graphic organizers and other teaching tools be uses to establish an academic and social meaning making relationship between African American children and mathematical word problems?

This report provides some data for generating ways to answer these questions. But math teachers should still examine the use of teaching practices to enhance African American students' problem solving skills. This approach creates more ways to develop a meaningful mathematical classroom culture. The norms of African American culture could also increase African American students' abilities to make meaning of word problems. Most importantly, they may also think more mathematically about how to solve math problems that define and transcend mathematics classrooms.

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Appendix A

Pretest

1. A 13ft ladder leans against a building. The bottom of the ladder is 6 feet away from the base of the building. How far up the side of the building does the ladder reach?

A. 19ft B. 16 ft C. 12 feet D. 8 ft

2. Shannon played an electric game. The game consisted of 30 questions, of which she gave 6 wrong answers. If Shannon played a game with 120 questions, she should get ____ correct answers.

A. 46 B. 96 C. 82 D. 108

3. A grasshopper is 25 feet north of a rabbit. Every time the grasshopper jumps 1 foot, the rabbit jumps 3 feet. If both the grasshopper and the rabbit jump due north, how many jumps will it take for the rabbit to pass the grasshopper?

A. 12 B. 9 C. 13 D. 7

4. Marcy played in 40 games of an 80-game basketball season. Her statistics for the year are as follows:

Rebounds: 10 Points Per Game: 14 Assists: 8

During the next basketball season, her statistics were as follows:

Rebounds: 15 Points Per Game: 21 Assists: 12

How many games did Bob play in during that basketball season?

A. 37 B. 60 C. 49 D. 72

5. Maurice paid Dalton $15.50 for a combination of 15 baseball cards and football cards. Each baseball card was $1.50, and each football card was $0.50. What is the largest number of baseball cards that were purchased from Dalton?

A. 8 B. 7 C. 9 D. 2

6. Barbara's parking garage charges $4.00 to park a car for the first hour and $1.25 for each additional or part of an hour and a half. What is the total charge for parking a car for 4 hours and 55 minutes.

A. $7.75 B. $6.25 C. $4.15 D. $5.00

7. A store has having a large Labor Day sale. The prices are reduced by 62.5 %, 54.5% 2/3, 66.2%, and 7/10. Which list shows the price reductions from greatest to least?

A. 7/10, 2/3, 66.2%, 62.5%, 54.5%
B. 66.2%, 2/3, 62.5%, 54.5%, 7/10
C. 7/10, 66.2%, 62.5%,2/3, 54.5%
D. 62.5%, 7/10, 66.2%, 54.5%, 2/3

8. Mario is twelve years older than Mike. He is six years younger than Bob. If A=Mike's age, then what is the equation for finding the age of Bob?

A. Bob=8(A)
B. Bob= A + 12 + 6
C. Bob=8-2 + 4
D. Bob =A +6-7

Pre-Test Results

Student Number	Gender	Test Number								
		1	2	3	4	5	6	7	8	Percent Correct
One	Female	X		X		X				38%
Two	Male		X	X		X	X			50%
Three	Female				X		X		X	38%
Four	Male	X			X	X		X		50%
Five	Female						X		X	25%
Six	Male	X	X							25%
Seven	Female	X		X	X	X				50%
Eight	Male		X				X	X		38%
Nine	Female	X	X	X						38%
Ten	Female	X			X	X				38%
Eleven	Female		X				X		X	38%
Twelve	Male	X								13%

Appendix B

The Kupanga Project
"Show Your Organization"

Week 1-Mathematical Word Problem 1

1. A rabbit and frog are racing to the finish line. The rabbit is 15 feet ahead of the frog and 30 feet from the finish line. When the rabbit jumps 2 feet, the frog jumps 4 feet. How many jumps are needed for the frog to pass the rabbit?
How many jumps are needed for the frog to win the race?

Week 2-Mathematical Word Problem 2

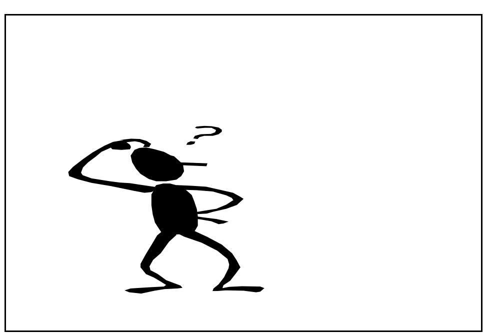
2. Bob, Tom, Belinda, and Rita took a standardized math test. Belinda earned a lower score than Tom. But she did not earn the lowest score. The highest scorer's name does not begin with a B. Rita earned a higher score than Tom. Which person earned the lowest score on the math test?

Week 3-Mathematical Word Problem 3

3. During his first four years as an engineer, Bob earned the following salaries:
Year 1-$71,000
Year 2-$77, 000
Year 3-$84,000
Year 4-$90,000
If Bob earned $98,000 during the fifth year, how much money will he earn during his seventh year?
A. $110,000 B. $113,000 B. $94,000 C. $99,000

Week 4-Mathematical Word Problem 4

5in.



2 in.

4. Barry used a scale of ½ inch=2 feet to represent his picture.
Which choice shows the representation of the feet of this mural?

A. 4 1/3 ft by 3 ½ ft
B. 20 ft by 8 ft
C. 7 ¼ ft by 10 2/4 ft
D. 12 ft by 3 ¼ ft

Week 5-Mathematical Word Problem 5

5. Mark paid $1100 for an oven. He also learned that he would pay an annual fee of $78.00 to operate the oven. Write an equation that best shows d, the total cost of the oven and cost of n, the number of years of oven operation.

Week 6-Mathematical Word Problem 6

6. Barbara and her son travel to the amusement park in Galveston, TX. When the family arrives at the amusement park, they learn the following information:

Winter Special
Adults-$12.00
Admission with Unlimited Rides

Kids-$6.00
Admission with Unlimited Rides

Regular Admission
Adults-$6.00 plus $0.50 per ride

Kids-$4.00 plus $0.25 per ride

Barbara son informs her that he wants to have unlimited access to all of the rides. If she only has $12.00, then:

A. Barbara can only get on 2 rides.
B. Barbara can get on the same amount of rides as her son.
C. Barbara can not get on any rides.
D. Barbara can get on between 3 to 6 rides.

Week 7-Mathematical Word Problem 7

7. Amanda is directing a reconstruction project of Interstate 35 in Texas.
Her job is to extend the interstate from 25 exits to 50 exits.
She is also required to order single digits for each of the new exit signs.

1. How many of each digit should be purchased to complete this project?

2. What are the total number of digits that will be purchased to complete this project?

Week 8-Mathematical Word Problem 8

9. The table shows the relationship between d, the number of new cars that are produced by a company, and e, the number of the damaged new cars.

Number of New Cars Produced (d)	Number of Damaged New Cars (e)
150	45
200	60
250	75
300	90
350	105

Which equation describes the relationship between the number of new cars and number of damaged new cars?

A. $e=.20d$

B. $e=\frac{d-40}{3}$

C. $e=d-.30$

D. $e=.30d$

Week 9-Mathematical Word Problem 9

9. Linda owns a beauty salon in inner city Houston. She charges $50.00 for a perm and $60.00 for a relaxer. She also charges 15% gratuity for each hairstyle. If Linda made $253.00 in 2 hours, she completed hair styles for ____ women.

A. 3   B. 2   C. 4   D. 7

Week 10-Mathematical Word Problem 10

10. Madeline and her 2 sons and 2 nieces decide to fly to their family reunion in South Carolina. In checking prices, Madeline learns that Delta Airline charges $450.00 to for flights in the "First Class" section of the airplane. Passengers must pay $300.00 to ride in the "Coach" section of the airplane. If Madeline has only $1700.00 for flights, how many people can fly in the "First Class" section of the airplane?

A. 1 B. 3 C. 2 D. 4

Week 11-Mathematical Word Problem 11

A beverage machine takes 4 minutes to fill a container with milk. The machine uses 6 minutes to fill a container with juice. The machine filled containers with milk and juice for 36 minutes.

At the end of this time, did the machine fill more containers of milk or juice?
About how containers of milk and juice were filled during this time?

Week 12-Mathematical Problem 12

2 men are filling a ditch. The first ditch digger is filling his ditch with dirt. The second ditch digger is filling his ditch with rocks. The first ditch digger needs 20 minutes to fill a fourth of his ditch with dirt. The second ditch digger needs 35 minutes to fill his ditch with rocks. Based on this information, you can conclude that:

A. The second ditch digger will need less time to completely fill his ditch than the first ditch digger.
B. The second ditch digger will need twice the time to completely fill his ditch than the first ditch digger.
C. The first ditch digger will need an hour to completely fill his ditch.
D. The first ditch digger needs about half of the second ditch digger's time to completely fill a fourth a ditch.

Appendix B

Graphic Organizer
Kupanga Paper

1. What do I need to know? (What is the question asking of me?)	Picturization 4. How does it Look? (How does "What I Need to Use" look?)
Sequentialization 2. What do I already Know?	Calculation 5. What is my Plan of Calculation? (What is the mathematical operation that was used? Show your organization.)
Sequentialization 4. Do I need to use all of what is known to find what I need to know? (Do I need to use all of my data?)	Validation 6. What is the Outcome? (Record your final Answer.) (How have you checked your answer?)

Appendix C - Post Test

1. A recipe for 5 waffles requires the following ingredients: 1 ½ cups of milk, 2 ¼ cups of flour, and 1 1/3 cups of sugar. How many cups of milk, flour, and sugar are needed to make 10 waffles?

2. A water tank contains 1,500 gallons. A faucet releases water at 5 gallons per 1 hour. If the faucet continues to release water at this rate, which equation can be used to find r, the number of gallons of water remaining in the tank.

A. R=1,500 divided by 5
B. R=1,500-60
C. R=1,500-60(5)
D. R=1,500 divided by 60(5)

3. Mario is planning a trip of 1,450 miles. He plans to drive between 250 and 300 miles each day. At this rate, which is a reasonable number of days it will take Mario to complete the trip?

A. Between 4 to 5 days
B. Between 2 and 3 days
C. Less than 4 days
D. More than 7 days

4. A train travels at 150 miles per hour. The equation below shows the relationship between d, the number of miles the train travels, and t, the number of hours it travels.

D=150t

How many miles will the train travel in 1 ½ hours?

5. Barry went to a barbershop for a haircut. The price for a haircut at this barbershop is $15, tax included. If Bruce tipped the barber 15% of the cost of the haircut at tax, how much change in dollars and cents should he have received if he paid with a $20 bill?

6. Johnny has a CD case that contains 4 rap CDs, 1 rock-and-roll CD, and 3 R & B CDs. What is the probability of Jerry randomly selecting a rap CD and then, without replacing it, randomly selecting an R & B CD from his case?

7. Lee, Kim, Linda, and Madison all took the same science test. Linda earned a lower score than Kim, but she did not earn the lowest score. The highest test scorer's name does not begin with a L. Madison earned a higher score than Kim. Which person earned the lowest score on the test?

A. Kim B. Lee C. Linda D. Madison

8. A Store sells potatoes in 5-pound bags for $2.40. Which of the following bags of potatoes would be the same price and pound?

A. A 15 pound bag for $7.20
B. A 7 pound bag for $1.25
C. A 10 pound bag for $5.00
D. A 17 pound bag for $17.00

Post-Test Results

Student Number	Gender	Test Number								
		1	2	3	4	5	6	7	8	Percent Correct
One	Female	X	X	X	X	X	X	X	X	100%
Two	Male	X	X	X	X	X	X	X		88%
Three	Female		X	X	X	X	X	X	X	88%
Four	Male	X	X	X	X	X	X	X		88%
Five	Female						X		X	25%
Six	Male	X	X	X		X	X	X	X	88%
Seven	Female	X		X	X	X	X	X	X	88%
Eight	Male	X	X	X	X		X	X	X	88%
Nine	Female	X	X	X		X	X	X	X	88%
Ten	Female	X	X	X	X	X	X	X		88%
Eleven	Female	X	X	X	X	X	X	X	X	100%
Twelve	Male	X	X	X	X	X	X	X		88%