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Ashley Johnson
Georgia College & State University

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Dr. Karynne Kleine
Faculty Sponsor

ABSTRACT

In recent years, there have been a number of studies regarding mathematics instruction. Specifically, efforts to address the achievement gap across the United States have been discussed and still the contributing factors and possible solutions have either been unacknowledged or partly recognized. Hence, the need for such research is critical and imperative to educating persons of the matter that exists within mathematics education today.

This study was conducted in a natural setting in which cognitive and cultural characteristics were explored in order to identify how such differences amongst students influence their exhibition of mathematical abilities. In particular, literature regarding cognitive style, culture in the classroom, and teacher preparation were consulted in order to establish a foundation for this study.

The research conducted and the implications that follow are significant to the discipline of mathematics and perhaps more importantly to teachers seeking to educate today's diverse group of students of mathematical concepts. Hence, the implications of this study are of great value and necessary for improving education at the national level as well as individual practices for mathematics instructors as well.

PREFACE

The following work is evidence of much time spent reading literature and conducting research in the classroom. My interests in this project came about from my aspiration to be a part of changing education at the middle level. In the past two years, I have taken many educational courses as well as acquired over 1200 hours of teaching in the field, which is the groundwork for my interest in cultural and cognitive differences prevalent in young adolescents. Hence, I was grateful to my professor, Dr. Kleine, for suggesting that I participate in the honors and scholar's project.

My research began with a question that I had about middle level education and specifically, my practice. This question would serve as the guide for my research and would be referenced throughout the process to ensure that the results of my work were significant to all who share concerns and/or interests similar to my study. After formally identifying a question that was significant to my practice, the discipline of mathematics, and to education generally, I worked closely with Dr. Kleine to write the literature review and methodology for this study. During this process, I also consulted two fellow scholars' students to review my work biweekly and discuss the next steps of the study. This joint and collaborative aspect served a critical role in the study in that it allowed me to produce a more comprehensive study. After completing the literature review and methodology, I collected data in a natural middle school setting in which I interviewed teachers and conducted reflective conferences with student participants. Following the data collection process, I began my analysis of the data in which I looked for commonalities in teacher and student responses, significant notes evolving out of the data, and any other information that appeared to be noteworthy to the study. Finally, I worked with Dr. Kleine to identify the implications of the study and write my final reflection.

The study well serves educational purposes and begins to answer questions associated with mathematics education on a national level. However, the fact that it raises questions about education and mathematics instruction particularly is more important.

Advice to Future Scholars Students

My advice to future Scholars students would be to take advantage of all the opportunities available at this institution, including participating in the Scholars program, as well as going on to publish your work. Although the process of writing a thesis, presenting, and possibly publishing are rigorous and time demanding tasks, the feeling of accomplishment when finished is even greater. Moreover, the wealth of knowledge and experience gained is vast and makes you distinct from others that leave your department with similar degrees.

If I were to do this project again, I would begin with a better plan for how the research would be collected and analyzed in order to meet all deadlines. In addition, I would make sure that I allotted enough time to conduct a more thorough analysis of the data as well as prepare for publishing my work. Nonetheless, I am grateful for the chance to present my work, which has in and of it self led me to a better understanding of my own work and the process of conducting research. I would also encourage future students to work with a supervising professor as well as individuals that participate in a similar field so that there are a variety of perspectives to contribute while conducting the research as well as a large support system.

Acknowledgements

I would like to begin by thanking Dr. Kleine, my mentor leader, for providing me with this opportunity. It is unquestionable that her faith in my abilities, high expectations and standards for learning, and noteworthy mentoring has had an impact on my research and teaching practice that is immeasurable. In addition, her commendable proofreading skills played an essential role in my success.

Secondly, I would like to thank my fellow colleagues, Bridget Snooks, Meghan Strickland, and Ashley Chesnut for helping me ask the right questions and develop reflective practices, both of which were essential to my process in conducting this research. I am appreciative to them for taking the time to help me although their schedules were busy and the to-do lists were never-ending. I could not have completed this project without their efforts.

Finally, I would like to express gratitude to the young adolescents that inspired me to do this type of work. Their willingness to learn and cooperation in the study has been the driving force behind my research. The need for more research relevant to educating all young adolescents is great and I am thankful in having played a part in increasing awareness of such matters at the middle level.

INTRODUCTION

For over a decade now, there have been discussions and publications that describe the achievement gap that exists in America. In the year 2004, The National Assessment of Educational Programs (NAEP) and the National Center for Education Statistics (NCES) issued a report that illustrated the achievement gap that plagues the nation. The report indicated that in 1990, there was a 33-point gap between the scores of African American and Caucasian students on the eighth grade level mathematic assessments whereas by the year 2000, scores the gap had grown to a 39-point difference. The report also indicated that African Americans are not the only minority population that appeared to lag behind as regards to mathematical performance. The same report indicated that Latino students were 28 points behind Caucasian students in 1990 and 33 points behind a decade later. The authors of the NAEP and NCES reports went on to elaborate that in the year 2003, of the fourth and eighth grade students tested, African American and Mexican American students were found to perform on average, statistically, three years behind Caucasian students in mathematics and language arts.

It can be noted then that one of the most significant manifestations of problems directly affecting American schools today can be attributed to the widening achievement gap in the area of mathematics between Caucasian and minority students (Johnson & Kritsonis, 2006).

In response to this dilemma, I posed the question: How do students' experiences outside of school (their culture) influence the cognitive style they apply in school generally as well as to mathematics learning in particular? In efforts to answer this question, I consulted literature pertaining to cognitive style, abilities and processes that are needed to perform in mathematics, and cultural traits of both African American and Caucasian students. Moreover, to seek the explanation for the widening achievement gap I also consulted literature on current teacher preparation programs as well as mathematics curricula.

LITERATURE REVIEW

Cognitive styles

Research literature is replete with discussions on the necessary cognitive style and abilities for individuals to successfully perform in the area of mathematics. Saracho (2003), in the article entitled Matching Teachers' and Students' Cognitive Style, defines cognitive style as the manner in which one receives, arranges, processes, and accepts new information. Saracho specified an important dimension of cognitive style, which she determined was the most informative: the dimension of field dependence or independence. She identified this as the most important dimension because of its association with an individual's perceptual style, personality, intelligence, and social behavior and thus well-describes a person's mode of perceiving, remembering and thinking as they apprehend, store, transform, and process information (Saracho, 2003). Saracho also identified and described two types of cognitive styles that were further categorized as field dependent (FD) and field independent (FI). Since there is a range to the styles that she identified, it is best to think of the degree of field independence/dependence characteristics as forming a continuum onto which most individuals' cognitive styles would be found.

Table 1, found in the Appendix and Figures section, provides a more detailed account of Saracho's description of the difference between field dependent and field independent individuals. The table indicates that field dependent individuals appear to be more social, more practical, and concrete learners, while field independent individuals appear to be less social, more analytical, and abstract learners. FD individuals appear to recognize wholes; that is, they look at an entire picture, foreground and background simultaneously, unlike FI individuals, who have the tendency and ability to look at parts of a picture separate from what surrounds it. This characteristic identifies a distinct and critical difference between the two types of cognitive styles that have implications for learning.

Research shows that in order for one to be successful in the learning and application of mathematics, one must have the ability to recognize parts first rather than wholes (Rowser & Koontz, n.d.). Furthermore, Rowser and Koontz also found that African Americans tend to respond to new concepts and or ideas in the holistic manner of a field dependent individual. This is noteworthy because it happens to be in opposition to the way that mathematical knowledge and skills are most easily acquired. Moreover, other researchers have found that being able to reason logically and use mathematical operation requires the capacity to think sequentially, process information in lists, and have analytical and reasoning knowledge and skills (Barber, Barber, & Kitchens, 1991).

While cognitive styles vary across race, there is a body of research to suggest that African Americans tend to learn in a style similar to that of a field dependent individual (Hunt, 1993). Hunt hypothesized that African American culture facilitates and supports the development of a field dependent learning style for those growing up within the culture. He further suggested that the call for unity and harmony that is found predominantly in African American cultures, but not in Western cultures, could explain the holistic cognitive processing approach prevalent in African Americans. Saracho's (1993) work supports Hunt's claim in the sense that aspects of African American culture are organized in a circular fashion as opposed to the linear representation seen in Western cultures. It is likely then, to some degree, that African Americans do exhibit a particular cognitive style that can be described as holistic, if not directly field dependent. Hunt further reminds us that the field dependent cognitive style that is critical for learning and applying mathematics runs counter to the field dependent style that most African Americans employ. It is apparent that there is a need to review current educational practices used in teaching mathematics to African Americans and to those who use a field dependent cognitive style for learning.

Mathematics as language

Joan Kenney (2005) opens her book Literacy Strategies for Improving Mathematics Instruction with a detailed account of how mathematics is a language in and of itself. She further describes how vocabulary, comprehension, reasoning, inference, symbol, and pattern exist in mathematics and explains how an individual must be able to note and apply all of the above. Kenney goes on to critique the current model of teaching mathematics due to its misalignment with assessments that are used to measure students' mathematical abilities. For many teachers, mathematics is simply a matter of cueing up procedures for students, who then perform the appropriate calculations; however, on both standardized and teacher-constructed assessments, students often are not able to interpret the problems. With no instruction as to how to process and arrange a problem for a solution, students fail because many have not developed the necessary skills for them to problem-solve without guidance (Kenney, 2005).

Teachers that instruct in such a cueing up manner, that is, those who teach procedural knowledge (how to, linear, not situation-specific) as opposed to conceptual knowledge (what it means, networked, context-bound), do a disservice to mathematics pupils. Wiest (2002) defines the mathematics instruction utilized by most math teachers today: "Currently mathematics is taught in a fashion that denotes that it is a universal language rather than a cultural one leaving many people at a disadvantage" (p. 51). Therefore, teaching mathematics procedurally would be inadequate for the students for whom context is a very important part of their ability to process information.

A related language and culture issue impinging on the widening mathematics achievement gap is reading instruction. A missing component of the mathematics curriculum for a number of years has been that of teaching reading in the mathematics classroom. Kenney (2005) informs readers of how math texts contain more concepts per sentence and paragraph than any other type of text. The argument of mathematics as a language both supports and highlights the problem many African Americans encounter as they learn and practice mathematics. Data issued in reports from NAEP (2004) and NCES (2004) describing the achievement gap that exists between Caucasian students and their minority counterparts demonstrated that African American students not only lag behind their peers in the area of mathematics but in language arts as well. If African American students do not acquire the knowledge and skills in language arts and reading, and if mathematics is defined as a language, it seems that the language gap is affecting the mathematics gap.

Teacher preparation and instructional practices

What roles do teachers and their instructional practices play in the widening achievement gap? Literature reveals that an individual's cognitive style and learning preference are not the only contributing factors to the achievement gap in the United States. The gap is not solely attributable to the learner, but possibly to the teacher. Therefore, literature on teacher preparation and instructional practices informed this study.

Instructional practices are related to teacher quality because teachers who are highly qualified have both strong pedagogical knowledge and strong mathematical knowledge (Johnson & Kritsonis, 2006). Unfortunately, the tendency is for the high-quality teachers to be assigned to majority-populated schools. It is a common occurrence for students in schools with a large minority student body and low-income populations to have fewer highly qualified teachers than schools that have large Caucasian populations (Gates, 1998). Johnson and Kritsonis further demonstrate that approximately 33% of high school math students in high minority schools and 30% of students in high poverty schools are taught by instructors who do not hold a teaching license nor were majors in mathematics. In contrast, approximately 7% of high school students in low minority and low poverty schools are taught by teachers without a license or a major in mathematics. In essence, minority students and students of poverty are less likely to be instructed by persons with strong pedagogical and content pedagogical knowledge. Moreover, Johnson and Kritsonis (2006) suggest that many minority students do not experience instructional practices consistent with recommendations suggested by the National Council Teachers of Mathematics, the preeminent professional organization dedicated to mathematics instruction.

Another possible deficiency in the state of instructional practices employed by many teachers is the mismatch between the teachers' and students' cognitive styles and/or characteristics (Saracho, 2003). Saracho, among others, argues that individuals tend to present information through a cognitive style that reflects their preference; this may not align with the preferred processing style of learners, creating situations that inhibit learning. Hunt (1993) supports this claim by stating, "Educators who neglect to adapt teaching strategies to different cognitive styles may be placing some students at risk" (p. 25). Furthermore, Hunt suggests that educational environments should be diverse enough to meet multiple cognitive styles.

Recognizing and understanding culture in the classroom

According to Hunt (1993), culture is a collective consciousness of a community with its own unique customs, rituals, communication style, childrearing patterns, and social organization. This definition is critical because it provides support that each culture then has its own set of values, beliefs, and behaviors that guide the lives of its members. One's cultural background then provides a lens that shapes how one looks at the world and views oneself (Wiest, 2002). Therefore cultural background, to some degree, has an influence on the manner in which individuals learn and demonstrate their knowledge.

Koontz and Rowser (n.d.) stress the idea of "culture-fair" curriculum as a possible solution to close the gap between African American and Caucasian students' achievement levels. "Culture-fair" is a curriculum that acknowledges and accepts the differences between and amongst cultural groups and then promotes their acceptance by developing and implementing a curriculum that is relevant to all students, thereby enabling them to have a successful academic career as measured by state and national assessments. This position acquires further support through the finding that the more familiar the instruction is to the students' way of life, the more likely it is that the teacher will be able to teach the individual (McCollough, 2000). Thus, understanding cultural and cognitive differences should be especially important to educators. If the educational system is oriented for those with field independent cognitive styles, many of whom fit a distinct cultural profile, those who utilize field dependent cognitive styles and have other cultural characteristics will be placed at a severe learning disadvantage.

Implications from the literature

Application of mathematics requires an individual to be able to think in a particular context, make reasonable inferences, and use logic to analyze and evaluate information. As it stands today, many students do not (and perhaps cannot) perform well in mathematics. This may be due to the lack of congruency between their cognitive style and the cognitive style that is better suited for learning mathematics. Fierro (1997) adds to this sentiment by suggesting that every child has a set of cognitive abilities and a learning style that can be traced back to his/her native tendencies and environmental experiences. In conclusion, there still exists a widening achievement gap between minority and Caucasian students and such a gap remains a national issue and concern (Johnson & Kritonsis, 2006). African American students continue to lag behind their peers in the areas of mathematics and language arts, and the future does not appear to suggest any sudden increases in performance without interventions such as a better understanding of how to address the problem. The study outlined below was an attempt to investigate this phenomenon.

METHODOLOGY

In order to investigate the influence of cultural and cognitive characteristics on the ways in which students exhibit their mathematical abilities, data was collected in a variety of modes from a selected group of participants in order to yield a sound and valid interpretation. The first considerations were the participants in the study, the length of time that was to be allotted to the study, as well as utilizing a means for allowing a representative sample of participants. All participants were purposefully selected to account for noteworthy variables embedded in the questions that propelled the study. As a student teaching intern for the 2007-2008 school year, it was important that I be able to carry out the study while conducting my other duties. Therefore, all study participants either attended or taught at Oak Hill Middle School located in Baldwin County and were currently placed in or taught seventh grade mathematics. The timeframe allotted for the data collection period was three weeks. The site for this study was determined not only because of its convenience but for its ability to produce a more representative sample of participants needed to increase the validity of the research and the results that follow. Wiersma and Jurs (2005) defined this type of selection process as purposeful sampling in which participants and study site is chosen for their characteristics relative to the phenomenon under study, rather than being selected randomly. The importance of using a representative sample for this study has been noted as being critical to the effectiveness of the data collection process and hence the reasoning for selecting student participants that differ through their current performance in mathematics class, reading ability, age, race, ethnicity, and nationality. Teacher participants were purposefully selected, in that they worked with the students who were being studied and were able to contribute to and explain student responses more thoroughly, which allowed for a more thorough analysis of the data. The data collection process took place over three weeks, at which time all participants had been selected and all modes of data collection had been utilized.

Interactive methods were used in gathering data. In particular, video observations, audio-taped student and teacher interviews, video-taped reflective conferences with students, and samples of student work were used as modes of data collection. Video observations were selected as a form of data collection in that they 1) could be referenced more than once, 2) provided a more accurate account of what occurred at any given point of time, and 3) allowed multiple approaches of analysis to be used in interpreting the data. The video observations were reviewed multiple times in order to note different aspects of the task and for the allowance of multiple approaches to explore the ways in which participants worked the task. The videos also provided a more truthful account in that one participant was not mistakenly identified as another, potentially rendering the interpretation invalid. Lastly, a video-taped observation allowed for multiple approaches to the analysis of the data that would not have been ordinarily granted in an observation without record. For example, the videos were initially analyzed to consider cultural characteristics and in another instance they were analyzed to note cognitive characteristics and how they influenced the student's performance.

Interviews with both students and teachers were conducted so that more perspectives were considered instead of a single viewpoint. Specifically, students and teachers were asked open-ended questions about instruction, mathematical difficulties in the classroom, and personal standpoints about mathematics in general. The data from the interviews was analyzed for trends and also any range of differences among the responses. The interviews were recorded so that they could be reviewed many times, thus leading to a thorough interpretation of the data.

This study involved the study of the relationship between cultural and cognitive influences on students' mathematical abilities In order to research the topic completely, conferences of the students' reflective process while working on the mathematical task were conducted to assist the students in their elaboration of thinking on their written work. For example, while the students were working on various tasks, questions such as "Why did you choose to do this first" or "What is your reason for choosing to divide in this instance but not in another instance." Using prompts to stimulate recall during problem solving incidents yielded data of greater breadth and depth of response than if the students were merely asked after the fact to explain their reasoning for completing a task in a particular order or style. The purpose of videotaping the conferences was to allow for multiple reviews, which were needed to ensure a legitimate and thorough interpretation of the data.

Samples of student work were collected to provide solid evidence of student ability and performance. The samples were categorized and analyzed based on the cognitive processes that the task either required or stimulated patterns and trends noted within student responses to interview questions, and any other pattern that emerged out of the analysis of the data. Lastly, the data collection methods utilized were thought to be the most adequate ways in which to investigate the study. Moreover, each method was chosen with the hope that it, combined with other methods, would lead to a more accurate account of what happened during the investigation thus enabling a more defined, valid, and significant interpretation to be made.

Data Analysis and Interpretation

Teacher participants

I began my research by interviewing all of the seventh grade teachers at Oak Hill Middle School, as they were the instructors of the student participants. The four instructors were diverse in their educational backgrounds and teaching experiences, though all were relatively youthful male and female teachers with a medium amount of experience.

When aggregated, the four math instructors shared 25 years of teaching. All of the instructors, with the exception of one, held a Georgia teaching certificate that would deem them as highly qualified to teach mathematics.

During their individual interviews, teachers were asked a range of questions regarding their knowledge and understanding of what knowledge, skills, and dispositions are necessary for the teaching and learning of mathematics, the manner in which he/she believed students are at a disadvantage or advantage in learning mathematics, influences that contributed to either the prohibition or inhibition of students' abilities in mathematics, and lastly their instructional practices as to how do they accounted for student differences in the classroom.

When asked the question, "What skills are required for an adolescent to be successful in learning and practicing mathematics," teacher responses were similar in that they all noted the ability to perform basic operations such as adding, subtracting as well as problem solving, reading comprehension, analytic, and reasoning skills. The responses indicated the teachers' content and pedagogical content knowledge in that they understand that mathematics requires a number of skills and abilities in order for students to be successful in learning mathematics. To some degree, the teachers implied that field independent learners would have to be able to utilize the skills necessary to learn mathematics more so than field dependent learners.

Secondly, the teachers were asked to identify any factors that would either inhibit or prohibit an individual from acquiring the necessary knowledge and skills they determined as being necessary to learn mathematics. Teachers provided explanations that included home environment, student affect, lack of mathematical learning experiences, and cognitive abilities in their responses. It is important to note that each teacher gave as the most important contributing factor the student's culture, and in particular, his/her home environment. In this response, the teachers distinctly conveyed, consistent with the literature, that one's culture has an influence on one's mathematical abilities.

Thirdly, instructors were asked to identify cultural inhibitors or cognitive characteristics that hinder students from learning mathematics. Cultural inhibitors included lack of exposure to language and mathematics material as well as the adoption of beliefs in reference to the value of education. Cognitive inhibitors stated were the inability to make connections amongst concepts, low reading comprehension skills, concrete (rather than abstract) thinking patterns, failure to make generalizations, and incapacity to view ideas out of context. Again, the teachers identified characteristics of field dependent or holistic learners as being those that have difficulty in learning mathematics due to their cultural and cognitive learning style.

Finally, teachers were asked to comment on their instructional practices. In particular, they were asked, "Given the factors that you identified in the earlier questions, are there any strategies or efforts that you have made as a teacher of mathematics to enable all students to learn mathematics?" Teacher 1 said that she provides one-on-one instruction, teaches metacognitive strategies that enable students to be aware of how they learn, and differentiates her learning plans to account for the different modalities and learning styles that exist. Teacher 2 said that he reinforces basic skills on a daily basis and uses individualized questioning techniques to scaffold (provide a bridge to promote understanding) individual learners. Teacher 3 said that she begins with what the students know before introducing new concepts. In addition, she begins instruction with tasks that require the learner to think concretely before being asked to think abstractly about a new concept or idea. Teacher 4 indicated that she uses graphic organizers to help students learn vocabulary and teaches procedures such as study skills and test-taking strategies to assist her students. It is evident by the range of responses as well as the nature of some responses, that half of the teachers instruct in a manner that would not assist field dependent students in learning mathematics. These teachers focus on teaching basic skills and procedures rather than emphasizing teaching students concepts and how to solve problems or reason. All of the teachers have over 80% African American students, yet only half of them teach in a manner that is responsive to the needs of the field dependent students. These data clearly illustrated the notion that mathematics instruction today is not reflective of the cognitive style that many African American students employ.

Student participants

The twelve student participants were all seventh grade students at Oak Hill Middle School and varied by gender, age, race, mathematical performance, and reading ability. There were an equal number of male students and female students. Two students were biracial, one female and one a male. Four students were African American with an equal number of females and males. Two students were Hispanic, male and female. The remaining four student participants were Caucasian, two males and two females.

The average reading level for the students was between a third grade level and eighth grade level with one outlier, a student that read on the eleventh grade level. The current math averages amongst the students ranged from the lower fifties to high nineties. Finally, the students' most recent Criteria Referenced Competency Test results supported the range of abilities amongst the students both individually and as a cultural group in both mathematics and language arts (see Table 2).

The students were given a mathematical task in which student knowledge and understanding of content and computation can all be measured and assessed. The description and details of the task are listed below.

> Mike and Larry are making three rectangular tables for the school system – one for the elementary school, one for the middle school, and one for the high school. The dimensions for the middle school's table are 4 feet wide and 6 feet long. The elementary table must be half the size of the middle school table. Since the high school table is going in the media center, it must be three times as large as the middle school table. Show as many proportional relationships among the tables using words, tables, and graphs as you can. Predict the dimensions for a college table that is twice as big as the high school table and twice the area of the new table.

The problem detailed above required that students know and understand the mathematical terms within and associated with the task, know and utilize the formulas for identifying the area of a rectangle, construct both symbolic and numeric equations, display data in the form of words, tables, and graphs, and make predictions based on the existing information that is either given or has been constructed by the student.

While completing the tasks, students were asked questions as they worked as well as prior to beginning and after they completed the task. The first question was designed to measure student affect as it pertains to mathematics. Students were asked to rate their confidence level in their ability to complete the task after reading the instructions. Fifty percent of the students said that they were somewhat confident; thirty-three percent indicated that they had very little confidence in their ability, and the remaining two students concluded that they did not have any confidence in their ability to complete the task. After answering this question, students were asked to identify the first step they would take to solve the problem and explain why. Three students said that they would read the problem again to identify what information was provided and think about what steps were needed to solve the problem. The other seven students indicated that they would write down the information given in the problem and attempt to solve the problem. Here was the first indication that the students possessed different cognitive styles, which would account for their ability to perform at a higher level than others. The students that said they would read the problem again proved to be the only students that either neared completing the task without help or successfully completed the task. Other differences observed in the students while working included their attitudes towards the task, comprehension and recall of information, knowledge of mathematical terms, ability to organize and display data, and awareness of ability or self.

In general, student affect was not particularly high for any of the students as the worked on the task. In fact, five of the students became frustrated to the point where they would have liked to stop working. Only two of the students exhibited excitement or contentment when they neared the end of task and determined the right solution.

Another noteworthy aspect of the study was the collection of data that enabled me to identify the levels at which student know, understand, and were able to recall information that pertained to the task confronting them. In efforts to identify the degree to which students were able to do this, I asked the students to recall the requirements of the task and describe the ways in which they attempted to solve the problem. Student responses yielded that the majority of the students could not fully account for what they had been asked to do in the task or the steps that they had taken to work the problem. The level of reading comprehension was particularly low for all of the students. Since only three students provided a detailed description of what they were asked to do in the task and listed the steps in chronological order that they had taken in order to work the problem I surmised that reading comprehension inhibited their success. This was revealed through the students' inability to recall information in order to organize data sequentially.

Mathematics can be described as a language in itself and in order for one to successfully work within the discipline one must know and understand the terms and symbols that are used within the content. It is imperative that students be able to recall the definitions of content terms while reading in order for the student to fully understand the task as a whole and further decipher what is being asked of them. Seven out of twelve of the students requested the definition or clarification of more than four of the mathematical terms within the task. The group of seven students consisted of all four of the African American students, the two biracial students, and one of the Hispanic students. It is important to note that although none of the Caucasian students requested information about the mathematical terms, not all of them understood the terms to the degree to which they could perform the requested action.

One of the skills necessary for one to be able to learn and practice mathematics is that of analytical thinking, that is the ability to arrange, process, organize, and store information sequentially, in lists, or diagrams that represent relationships amongst data sets. When the students were asked to describe the proportional relationships that existed among the tables using words, tables, and graphs they were essentially being asked to organize and reorganize the information into different representations. Using tables and graphs required them to use more analytical processes as opposed to writing the relationship in words to create a sentence. All of the students were able to create a table to display the data; however only one of the students was able to accurately construct a graph to display the data. In addition, only four of the students—the Hispanic male, both African American females, and one Caucasian female—chose to represent the relationship using words.

Lastly, the ability of learners to identify and utilize strategies that are essential to their success in mathematics must be developed and maintained. That is, an individual's metacognitive awareness is an important factor in one being able to learn mathematical concepts, construct understandings that evolve out of knowing the concepts, and perform the skills and operations associated with the discipline. The students were asked to identify the measures that they had taken that helped them to solve the problem as well as the skills that they used. In their responses, students said they needed to know what the "words" meant, how to perform basic operations such as adding, subtracting, and multiplying, and how to think about the problem in different ways in order to explore all possible solutions. They seemed to acknowledge the elements that would enable their success. However, they did not possess the elements and therefore were generally not successful in solving the problem. In general, factors that accounted for the small number of students that were able to successfully solve the problem included students' affect, low reading comprehension ability, insufficient knowledge of vocabulary terms, inability to perform basic operations, lack of ability to process and organize information sequentially in the form of lists, tables, and/or graphs, and incapacity to make valid predictions based on what is known or given in a problem.

Summary of Findings and Reflection

Mathematics, more so than other content areas, is a cumulative discipline. The knowledge, skills, and understandings build on one another and the concepts embedded in the discipline interweave and link to each other in more ways than one. Mathematics, as defined by the National Council of Teachers of Mathematics (n.d.), is a study of patterns and relationships; a science and a way of thinking; an art, characterized by order and internal consistency; a language, using carefully defined terms and symbols; a tool. Here we see that mathematics then does not primarily focus on arithmetic skills or computation; instead, the focus of mathematics is a process. In contrast to the way mathematics needs to be learned and taught, teachers have dedicated much of the curriculum to adding, subtracting, and other operational tasks in order to ensure that students arrive at the correct product or answer rather than focusing on teaching students how to think about math in a manner that allows for the arrival at a more sound and valid solution. As noted earlier, two out of four of the mathematics teachers have found it necessary for them to drill the students through basic skills practice and assessments. Could the students not practice their skills through the learning of new concepts or solving word problems? It seems more of their instructional time is consumed with ineffective practices such as teaching skills in isolation and without context, especially considering that this method has been proven unsuccessful for many in recent years.

It exists today that many African American students, due to their culture, employ a particular field dependent cognitive style that has been inadequate in assisting them to learn mathematics. If this is the given and such strategies have yet to be identified that will automatically change one's cognitive style, then we must assume that the most reasonable and just solution would be for math educators to change their instructional practices. That is, we should better align our instructional practice to the cognitive style of the students we serve. Saracho (1993) discussed matching teachers' and students' cognitive styles when she stated, "Recognition of [the discrepancies between teacher and learner that exist in the classroom] and acknowledgment of their effects must be dealt with when planning and implementing any classroom learning experiences" (p. 170). The effects of the interactions between the teachers and students' cognitive styles must be considered in selecting instructional strategies and establishing an environment conducive to learning. When teachers were asked in what ways they accounted for the differences amongst students in their classes, only one of the teachers identified ways in which it is apparent that she understood that the learners are different and was aware of how she designs her lessons and structures her curriculum to address student differences. The lack of recognition and acknowledgement of differences by the teacher participants in this study plays a possible role in the students' inability to learn mathematics.

Another contributing factor to the students' lack of performance might be linked to their affect regarding mathematics. On average, the students indicated that they had very little confidence in themselves prior to beginning work on the task; in addition, they exhibited little enthusiasm or excitement while working. Research shows that when students are enthused and engaged in a lesson, learning tends to take place. Implications of this are that instruction needs to allow for the students to become active and engaged in the lesson, thus creating an atmosphere that establishes anticipation and excitement as opposed to dullness and boredom these students expected when learning mathematics.

While not necessarily related to cognitive or cultural styles, this finding further supports the notion there is a misalignment between mathematics instructional practices and those that would be effective for the majority of the students.

Interestingly, both teachers and students lacked in their ability to reflect upon their practices and explain how those practices affect their performance. Metacognition and reflection are both critical components that exist within individuals that practice mathematics effectively. Both metacognition and reflection enhance the individuals' ability to think critically and increase their overall thinking and reasoning skills, analytical abilities, and reflective thought process. Addressing these two skills then must be incorporated in to the teacher's practice as well as his/her instruction so that the students' have opportunities to develop these skills.

Additionally, students in mathematics classrooms should be engaged in tasks that enable them to become mathematically literate to the degree that allows them to fully understand how what they are learning can be connected to other things and in particular, can be connected to their life and applied to the world that surrounds them. In essence, they can be assisted in moving along the continuum from field dependent learning to field independent learning as they are exposed to strategies that enable them to judge the important aspects of a situation. It is only though the thinking and reflective process that students can acquire the understanding of mathematics and themselves that is needed for them to be successful within this discipline.

Attempting to close the achievement gap then begins with preparing teachers to instruct students that are both field-dependent and field-independent processors. It starts with accepting and rewarding field-dependent learners as they are instead of punishing them for what they are not. It continues with equipping learners with the dispositions and knowledge they need to move them through the learning continuum, which is done by the instructor through the types and number of learning experience he/she provides for the learner. The goal and solution then is to make instruction and assessment learned-centered so that they reflect the needs of the student and gradually move the learner to where he/she needs to be in order to perform at the highest level. Teachers must do this through the decisions they make through scaffolding and modeling rather than through to labeling, tracking, and punishment that often takes place in the educational system today.

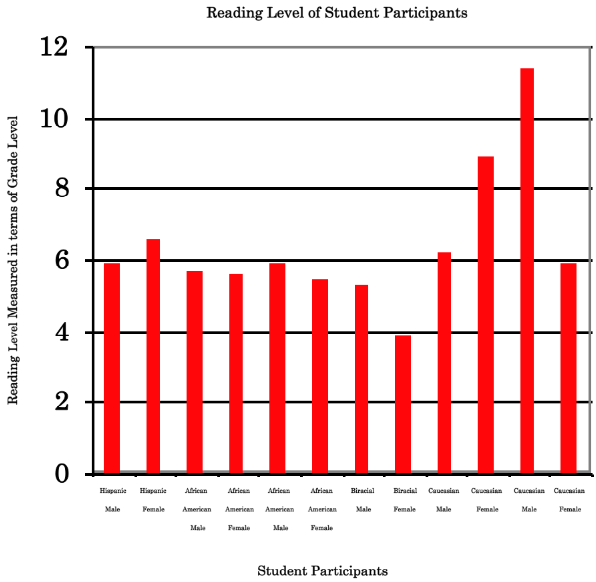
APPENDIX AND FIGURES

Table 1: Characteristics of Field-Dependent and Field-Independent Individuals

Field-dependent individual	Field-independent individual
1. Rely on the surrounding perceptual field	1. Perceive objects as separate from the field
2. Experience their environment in a relatively global fashion by conforming to the effects of the prevailing field or context	2. Can abstract an item from the urrounding field and solve problems that are presented and reorganized in different contexts
3. Experience an independence from authority,	3. Are dependent on authority which leads them to depend on their own standards and values
4. Search for facial cues in those around them as a source of information	4. Are oriented towards active striving
5. Are strongly interested in people	5. Appear to be cold and distant
6. Get closer to the person with whom they are interacting	6. Are socially detached but have analytic skills
7. Have a sensitivity to others that helps them to acquire social skills	7. Are insensitive to others, lacking social skills
8. Prefer occupations that require involvement with others	8. Prefer occupations that allow them to work by themselves

*Note: Copied from p. 154

Table 2: Reading level of student participants



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