# CASE STUDY

# CULTURALLY RELEVANT DESIGN PRACTICES: A CASE STUDY FOR DESIGNING INTERACTIVE ALGEBRA LESSONS FOR URBAN YOUTH

By

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*ABSTRACT*

*When culture is integrated into the mathematics classroom, it improves students' academic achievement, helps move classrooms towards an equitable learning environment, helps students to have positive beliefs about mathematics, and integrates mathematics with other disciplines. Moreover, if you observe today's kids, the use of video games in their daily and/or weekly routines is significant. Lastly, the predominant genre among African-American youth is hip- hop/rap. These facts led to a process for designing culturally relevant educational games for engaged learning. As a byproduct of this process, the African-American Distributed Multiple Learning Styles System (AADMLSS pronounced 'adam less') City Stroll was created. AADMLSS is an adaptive, electronic, speech-enabled algebra learning system that uses culture to influence learning in the form of an animated, music-led interface.*

## INTRODUCTION

Having access to strong algebra instruction in middle school can prepare students to complete higher levels of math in high school and thus to be competitive for college and gain access to important technological fields of study at advanced levels (Nasir et al, 2006). Studies show that the issue of math and youth has a far-reaching and devastating impact in other aspects on students' lives throughout their lifetime. Consequences include limiting opportunities for students in higher education, employment, and earnings (Lee, 2002). Numerous math tutors have been developed and designed in response to the understanding of the importance of mathematics. For example, SoftMath has introduced Algebrator, an intelligent algebra tutor specifically designed to teach pre-college algebra; the student can enter any symbolic problem the tutor will then solve the problem step-by- step and provide context-sensitive explanations (Algebra Tutor, 2007). Additionally, Cognitive Tutor by Carnegie Learning, is an intelligent instructional software, designed as a curricula to be used in a classroom environment where it combines computer-based training, text, and teacher-led classroom instruction that supports guided learning by doing (Aleven & Koedinger, 2002).

Unfortunately, even with these targeted tutors, there is still a huge gap that exists between minority students and their Caucasian counterparts in mathematics performance. This racial inequality in student outcomes between minority students and their Caucasian counterparts has raised a multitude of concerns and resulted in a significant body of empirical research (Lee, 2002). Despite decades of attention, gaps in the achievement of minority students remains one of the most pressing problems in education and has maintained its place in the forefront of discussion regarding African American urban youth (Johnston & Viadero, 2000). Studies have shown that African American youth continue to lag

behind, despite various efforts to bridge the gap. The performance of African American and Latino youngsters improved dramatically during the 1970s and early 1980s however by the late 1980s progress stalled and began to stagnate and the gaps started growing (Lee, 2002; Haycock 2001). In 1996 several national tests found African American and Hispanic 12th graders scoring at roughly the same level in reading and math as Caucasian 8th graders (Haycock, 2001; Johnston & Viadero, 2000). The 7th National Assessment of Educational Progress (NAEP), results showed that, at the fourth grade level, 28% of White students are at or above the proficient achievement level, while 8% of Hispanic students and only 5% of African American students are at or above the proficient achievement level (Gilbert et al. 2008). The disparities in school performance tied to race and ethnicity shows up in grades, test scores, course selection, and college completion (Johnston & Viadero, 2000).

At the heart of this concern of the achievement gap is the question of urban youth and math, specifically among African American kids. The significant problem of African American students in America's schools of the wide achievement gap in mathematics achievement is a serious concern in mathematics education (Gilbert et al., 2008; Johnson & Kristsonis ). Johnson & Kristsonis (2006) explains that in 1990, there was a 33-point gap between the scores of African American and Caucasian students on the National Assessment of Educational Programs (NAEP) mathematics test at the eighth grade level as compared to 2000 scores; the gap had grown to a 39-point gap. The decline is seen to continue in 2003, where of the fourth and eighth grade students tested, African American and Latino students were found to perform on average, statistically, three years behind their Caucasian counterparts in math and language arts.

There is hope, however, in addressing this problem through the design of culturally relevant pedagogy. Thinking and learning are all related to the context in which they occur, thus the participation in cultural practices influence mathematics thinking and learning (Nasir, 2000). Equity in mathematics education can be achieved by contextualizing the learning experience in the cultural practices of the learner. Thus a design that accounts for the consequences of practices obtained from culture participation is an avenue worthy of exploration and the focus of this body of work.

### Culturally Relevant Pedagogy

"The equitable distribution of opportunities to learn powerful mathematics is clearly one of the most pressing issues in the multiple gaps in mathematics education that exist at the intersection of cultural and domain knowledge" (Nasir et al 2006).

#### *Defining Culture*

Learning through culture can become a difficult concept to investigate because of a lack of agreement as to what 'culture' is (Eugene & Gilbert, 2008). Gutierrez and Rogoff (2003) argue against the common approach of assuming that regularities are static and that traits of individuals are attributable categorically to ethnic group membership. As a result, they claim, variations reside not as traits of individuals or collections of individuals, but as proclivities of people with certain histories of engagement with specific cultural activities. Individual's and group's experience in these activities, should become the true focus in defining culture (Gutierrez and Rogoff, 2003).

Since culture is a prime determinant of an individual's development (Vygotsky, 1978), it has an immediate impact on her ability to learn. Both Lave and Wenger's Situated Learning Theory (1990) and Ausubel's Meaningful Learning Theory (Driscoll, 2000) support the fact that learning is a function of culture, and a learner's ability to comprehend is enmeshed in her ability to related new information to previous experiences. In a recent study, researchers have shown the magnitude of culture influences on brain function, and how widespread the engagement of the brain's attention system became when making judgment outside the cultural comfort zone (Delude, 2008). Everyone uses the same attention machinery for more difficult cognitive tasks, but they are trained by culture, thus trained to use it in different ways.

By-products of culture participation are the diverse and socially mediated transactions manifested through events and activities, labeled as funds of knowledge (Moll

& Greenberg, 1990). "Our perceptions of objects and events in the natural world are strongly dependent on our store of prior knowledge ... we view the world through a pair of 'conceptual goggles' " (Mintzes & Wanderse, 1997). These conceptual goggles are heavily influenced by culture. When one identifies with a specific culture, this is manifested in many ways, e.g. appearance, thought, and lifestyle (Gilbert et al., 2008). Making use of the knowledge already familiar to the learner, to teach new knowledge can help create a mental model to map onto their schema, adding meaning to the new knowledge for the learner (Moll, Amanti, Neff, & Gonzalez, 1992). In the realm of design practices, how do we leverage cultural knowledge or funds of knowledge as a means to teach algebra lessons for urban youth? To being, this process, a clear definition of culture must be established.

In order to build culturally relevant instruction, the authors define culture along two dimensions: what we do and who we are. Regular participation in specific activities or the things we practice is "what we do", e.g. religious beliefs, political affiliation, music and entertainment. The second dimension is "who we are," which refers to our physical and/or visually observable attributes such as appearance, e.g. height, weight, skin tone, eye color, clothing, and other attributes, e.g. gender, age group and class.

## Designing Interactive Algebra for Urban Youth using Culture

### *Detailed Design*

There are both long-standing racial gaps in mathematical achievement and course-taking patterns and the traditional separation of formal mathematics from the experience of young people (Nasir et al, 2006). Several researchers have turned to innovative pedagogies that use culture to improve mathematics achievement amongst students of African descent, with the premise that, integrating culture into the mathematics curriculum promotes mathematical understanding (Gilbert et at, 2008).

MindRap is a multimedia education program which was developed by Tiz Media (2008). MindRap uses Hip-hop music and interactive multimedia to teach science and math. The MindRap lyrics for the African American Distributed Multiple Learning Styles System (AADMLSS), City Stroll multimedia modules supported curricula designed lessons using scenarios which reflected several mathematical methods for solving linear algebraic equations. The goal was to develop culturally relevant lessons using a multimedia game-like environment to deliver the instruction. In this, culture was defined by first identifying the students and their culture (who they are and what they do). The students were African American urban youth in Chicago, Illinois. Upon review, the authors discovered the "what they do" dimension of the students' culture as follows:

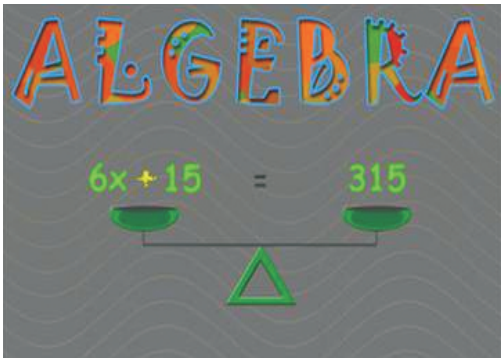
1. Most of the male students played video games.
2. All of the students listened to hip-hop or rap music.

The second, or the "who they are," dimension contained attributes such as:

1. All of the students were African Americans.
2. They were split equally male and female.
3. They all came from middle to low-income homes.

Using these cultural dimensions, the team began to develop a conceptual model for the tool.

The MindRap team began by systematically exploring the general concept for solving algebraic equations and a pedagogical structure was designed for hip-hop or rap




*Algebra Algebra Algebra Algebra*
Algebra is tight once you balance it right,
Fun like a puzzle, the ultimate game,
Solve the equation with equality, its gotta be both sides,
Catch mysterious X, Do both sides
Get a clue from the operator, listen to the operator
*Do both sides*

Figure 1. Chorus lyrics and screen shot

lyrics. Because of the significance of algebraic operators and the need to balance both sides when solving linear algebraic equations, the conceptual information was mapped out in the choruses (see figure 1). After the logic used to solve the linear algebraic equations was mapped out, narratives that included essential story-telling elements were put in a meaningful context. In order to help students understand the relationship to algebra in their everyday lives, scenarios showing examples of how math can be used in real life were illustrated in the verses. It followed that the pedagogical approach for building these multimedia modules was focused on providing the mathematical rules along with examples of practical application. The verses reflected the individual methods for solving algebraic equations and the chorus reflected the over all concept and applicable rules. The chorus included the elements of balance, solving for an unknown, and the role of the operator in solving algebraic equations. These elements were used to create storyboards that depicted the flow of the rap.

In order to provide an accurate cultural perspective, the MindRap team used a participatory design (Muller & Kuhn, 1993) approach to the development of the hip-hop/rap lyrics. An eighteen-year old rap artist was an essential part of the team. This artist created the narrative and turned it into a rap using a musical selection that he and the music director for the project decided on. The rap was reviewed, checked for consistency, and edited according to bar count and content. The rap was recorded, edited, mixed, processed and used as a guide for the graphics production (see figure 2).

Next, the team created a storyboard that reflected the lyrics highlighting the aspects that we felt required visual support. Based on the storyboard and the second cultural dimension of the students, a graphics artist created the Hip-hop characters and graphics that accompanied the lyric's choruses (see figure 1). Characters were developed that reflected urban youth. The characters and flow of each story were coordinated with math in each scenario's narrative (see figures 3-5). For example, we needed to answer why the character Malik, a young African-American urban teenager who is

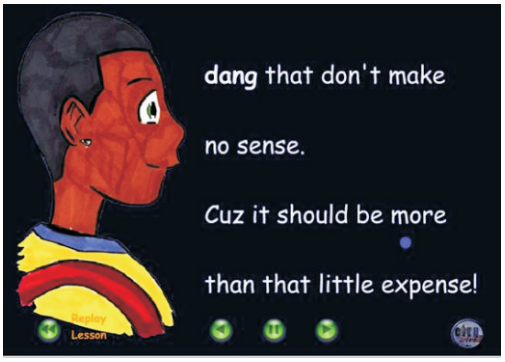
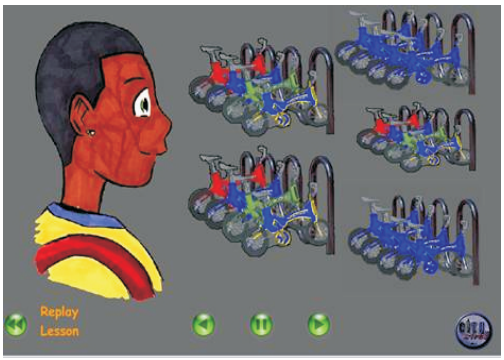
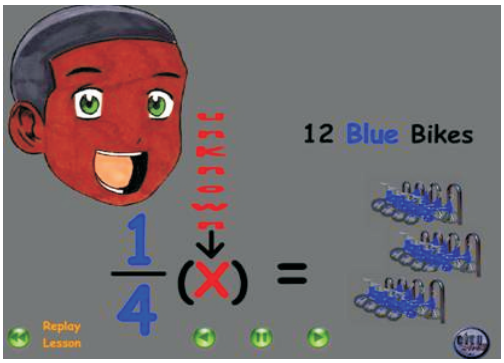



Figure 2. Rap lyrics








Figures 3-5. Math Scenario

the focus of all scenarios, would want to know how much an individual candy bar would cost in order to make the story coherent. An additional area of coherence came into play with the integration of some of the 3D graphics that made up the City Stroll environment into the storyboard. Once the graphics were created, they were scanned, touched up and animated to support the lyrics (see figure 6).

## Findings

A brief study done in an inner city school in Chicago showed that the design was well received among the target audience. Results showed that participants were engaged and interested in the lessons. In the study participants were surveyed about the City Stroll environment and engagement. On a one to five likert scale, with 5 being the highest, engagement ranked 4.26 overall (see Table 1). Participants enjoyed the rap lyrics and thought that they were understandable, stating "This kept our attention because it had music along with it….


Figure 6.

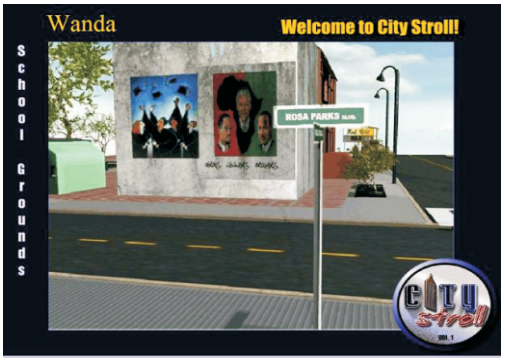



Figure 6 & 7. City Stroll Graphics

| | Overall | | Males | | Females | |
|---|---|---|---|---|---|---|
| Survey Item | M | SD | M | SD | M | SD |
| | | | Environment | | | |
| Overall Enjoyment | 4.26 | 1.14 | 4.10 | 1.37 | 4.38 | .961 |
| Kept their Attention | 4.26 | 1.01 | 4.30 | 1.06 | 4.23 | 1.01 |
| Interesting | 4.39 | 1.08 | 4.40 | 1.26 | 4.38 | .961 |
| Should have Looked more real | 2.78 | 1.54 | 3.40 | 1.17 | 2.31 | 1.65 |
| Felt real | 2.91 | 1.38 | 2.70 | 1.34 | 3.08 | 1.44 |

Table 1. Study Results: Environment.
Adapted from Gilbert et. al, 2008; pg 26

songs stick in your head more" (Gilbert et. al, 2008; pg 26). The preliminary findings suggest that this approach is engaging; however, we haven't found a significant difference in learner outcomes, yet.

## Conclusion

The reality of the widening achievement gap in mathematics among African American students has long-term societal repercussions. These high stakes demonstrate a need for designs that tap into all aspects of the learner to engage them in the learning process. Existing systems do not present a cultural relevancy to any targeted audience. We are proposing a user-centered approach to the design of algebra tutoring systems. Integrating culture, (what we do and who we are) into instruction allows the learner to connect their own life experiences to the learning process and presents culture via an acceptable medium for the learner thus increasing interest and participation. AADMLSS City Stroll demonstrates culturally relevant lessons using a multimedia game-like environment to deliver the instruction of several mathematical methods for solving linear algebraic equations. The preliminary findings suggest that AADMLSS City Stroll is engaging and the students tend to use the tutor longer. In the future, additional studies will be conducted to measure learner outcomes and to see if learning is improved using AADMLSS City Stroll and other culturally relevant multimedia. It is possible that culturally relevant pedagogy delivered through an electronic algebra tutor such as AADMLSS may be part of the solution to closing the

achievement gap in mathematics among African Americans, Hispanics, and Native Americans.

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