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# Urban Public High School Teachers' Beliefs about Science Learner Characteristics: Implications for Curriculum

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# URBAN PUBLIC HIGH SCHOOL TEACHERS' BELIEFS ABOUT SCIENCE LEARNER CHARACTERISTICS
## Implications for Curriculum

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*This qualitative study addresses the link between urban high school teachers' beliefs about their students' preparedness to achieve success in science and the teachers' reported curricular responses to those beliefs. Eight high school science teachers from schools representing a range of achievement levels were interviewed using semistructured, in-depth interview techniques. The findings suggest that teachers view science as a special subject that requires special qualities. Teachers saw their own students as largely lacking in those qualities needed for success in science and reported such modifications to the curriculum as "slowing down," deemphasizing some topics, and reducing the depth of coverage.*

***Keywords:*** *teacher beliefs; urban science education; science learner characteristics; teacher perceptions; urban science curriculum*

**Urban public schools in the United States** are challenged by the same complex social and economic problems that afflict the neighborhoods and communities they serve. Such schools have been described as places where "school personnel are required to teach students in antiquated facilities, with minimal staff development, and decreasing budgets" (Ennis, 1995). There is no shortage of research that gives evidence that urban schools are underresourced, woefully underachieving, and populated largely by students who live in disadvantageous economic circumstances (Lee, 1999;

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Seiler, 2001). Furthermore, the curriculum in such schools has been described as limiting (Ennis, 1995), low-level, fragmented, and based on what Haberman (1991) calls “a pedagogy of poverty” (p. 293). Urban schools serve populations that are predominantly poor and made up largely of students from underrepresented groups, most of whom are African American. The often-lamented problem of underachievement in such schools is thus largely a problem of the underachievement of poor, African American students.

This study is premised on the view that student learning outcomes are determined in large measure by the nature of learning experiences. Thus, a study of the school and classroom experiences of urban children might hold the key to an understanding of the problems of underachievement that plague this population of students. This study probes one aspect of the classroom experiences of African American urban high school students. Specifically, the study looks at teachers’ beliefs about these students’ ability to succeed in science with a view to determining how these beliefs might be linked to the teachers’ classroom practices.

Achievement gaps between African American and White students have been persistent. Recent evidence of this is seen in the *National Assessment of Educational Progress 1997 Report* (U.S. Department of Education, 1997), which shows disparities in a range of subject areas based on data collected in 1996 (Rodriguez, 1997). The trend continued in the 2000 data. Across all of the grades that were assessed, and for both years 1996 and 2000, Blacks trailed all other racial groups. In addition, in 1996, only 4% of Black 12th-grade students attained “proficient” level or above, whereas in 2000, that proportion fell by 1 percentage point to 3%. Among White counterparts, those numbers were 27% in 1996 and 23% in 2000. The results of the *Third International Mathematics and Science Study* (National Center for Educational Statistics, 1995) also bear this out. The poor standing in mathematics and science achievement of U.S. students relative to students from other participating countries was widely publicized. Much less known is the fact that when the data are disaggregated, and Caucasian, African American, and Hispanic students from the United States are considered separately, White students were outperformed by only three nations, whereas African American students were outperformed by all others (Berliner, 2001). The reforms that have been initiated in response to America's low performance relative to the other countries include standards-based teaching, high-stakes testing, and increased school and teacher accountability. These, however, fail to address the specific reasons for underachievement of African Americans or other underrepresented groups.

Research into the causes of urban African American underachievement in science has typically looked at two groups of factors. On one hand, there is the cultural difference argument, which suggests that there is a mismatch between aspects of the culture of science and the culturally influenced understandings that students bring with them to their science learning. This argument encompasses the notion that traditional school science is Western science and is premised on a Western worldview, which is different from the worldview espoused by many underrepresented groups and may actually be alienating to students. Another aspect of the cultural difference explanation has to do with the alleged lack of relevance of the contexts in which science concepts are presented to the cultural contexts in which African American students live their lives. In another construction of the cultural difference argument, Norman, Ault, Bentz, and Meskimen (2001) have characterized urban science classrooms as "cultural interface zones" in which the culture of science as an intellectual discipline, the culture of the teachers, and that of the students might be in conflict (p. 1103). When the power imbalance inherent in such conflict is not satisfactorily negotiated, achievement suffers. In all of these arguments, the underachievement of African Americans is thought to be due in part to a failure on the part of science curricula to bridge the gap between the world of the student and the world of science. The other group of arguments about urban African American failure in science has to do with characteristics of the urban school learning environment. In a nutshell, these explanations suggest that the schools are underresourced, the teachers are underprepared, and this results in student underachievement. It is probably true that the causes of underachievement are complex, multiple, and interacting. If that is the case, then studies that employ holistic methodologies to investigate the nature of the curricular experiences of urban African American learners are most likely to yield useful insights into the problem.

This study is based on the conception of curriculum advanced by Schwab (1970). Schwab suggested that the enacted curriculum is the result of the interaction of the four commonplaces of curriculum: the teacher, the subject matter, the student, and the milieu. Changes in any one of these commonplaces, in effect, alter the received curriculum even when the manifest curriculum is the same. It is evident, then, that even within a single school district, children in different schools might be experiencing substantially different curricula. This study addresses the teacher component of the enacted high school science curriculum in an urban school system. It explores the beliefs of science teachers about the determinants of success in high school science and their evaluations of their own students with respect to those determinants. The study is the beginning of a series of investigations that undertake an in-depth exploration of the science curricular experiences of urban high school students in a predominantly African American school system. It responds to the call made by Cochran-Smith (2000) and echoed by Bryan and Atwater (2002) for research that makes explicit the "assumptions, attitudes, beliefs and practices about schools, teaching, students and communities" that influence teachers' instructional decisions (Cochran-Smith, 2000, p. 158). The study makes the assumption that the reasons for the underachievement in science seen among urban African American high school students are to be found, at least in part, in the nature of their science curricular experiences. It further assumes that an understanding of the curricular experiences teachers provide for their students cannot be gained apart from an understanding of the beliefs that underpin teachers' instructional decision making.

## THEORETICAL FRAMEWORK

This study is framed within a well-established body of literature that affirms the influence of various aspects of teacher thinking about students, and about teaching and learning, on classroom practice and learning outcomes (Braun, 1976; Brickhouse, 1990; Briscoe, 1991; Brophy & Good, 1970; Clark & Peterson, 1986; Cochran-Smith, 2000). Teacher beliefs are among the most widely researched aspects of teacher thinking. Brophy and Evertson (1981) distinguished between beliefs, as statements held to be true; expectations, as cognitive predictions; and attitudes, as affective or emotional responses to objects or people. Nespor (1987) distinguished beliefs from knowledge and asserted that they have strong affective and evaluative components, are rooted in personal history, and are not easily changed. Pajares (1992) placed beliefs within a constellation of related constructs that includes attitudes, expectations, values, opinions, perceptions, conceptions, and dispositions, among others, all of which exert powerful influences on behavior. Bryan and Atwater (2002) also proposed that "beliefs are part of a group of constructs that describe the structure and content of a person's thinking that are presumed to drive his/her actions" (p. 823).

It is this relationship between belief and behavior that makes the study of teacher beliefs so critical to an understanding of educational outcomes. Several researchers have affirmed the centrality of teacher beliefs in the realization of educational reform (Bybee, 1993; Haney, Czerniak, & Lumpe, 1996; Tobin, Tippin, & Gallard, 1994). Whereas such bodies as the American Association for the Advancement of Science (1993) and the National Research Council (1996) have also recognized that teachers are key determinants of the success of the reform policies that they advocate, Levitt (2001) reminded us that the implementation of these reforms "requires considerable adaptation of teachers' beliefs" (p. 1).

This study makes no attempt to differentiate beliefs from the range of other closely related constructs but uses the term *beliefs about learner characteristics* to capture the range of dispositions about students that might be influencing teachers' classroom actions. For the purposes of this study, the notion of teachers' beliefs about learner characteristics encompasses such aspects of teacher thinking as expectations about student outcomes; beliefs about learner characteristics such as race, ethnicity, class, and gender; and beliefs about students' ability and performance in science. The article thus draws on relevant literature about a range of these constructs to establish the importance of teacher thinking to practice.

More than three decades ago, the seminal work of Rosenthal and Jacobson (1968) alerted educators to the effects of teacher expectation on student outcomes. More recent research in urban settings has supported this finding, showing a strong relationship between high teacher expectation and student success (Entwisle & Alexander, 1988; Ladson-Billings, 1994). With regard to teacher beliefs, researchers have investigated the effects of elementary teachers' beliefs about the teaching and learning of science (Bryan, 2003; Levitt, 2001), prospective science teachers' beliefs about constructivist teaching practices (Haney & McArthur, 2002), and teachers' beliefs about the nature of scientific content knowledge and teaching and assessment practices (Yerrick, Parke, & Nugent, 1997). The body of research on teacher thinking demonstrates that teacher beliefs about teaching and learning affect many aspects of classroom practice, including lesson planning and the assessment of student learning (Pajares, 1992; Richardson, 1996; Taylor & Macpherson, 1992).

Teachers' beliefs about the characteristics of their students have not been as frequently investigated. Yet, it is possible that it is this class of teacher beliefs that has the most telling effect on student outcomes. Shepardson and Pizzini (1992) found that teachers held gender-biased perceptions of the scientific ability of their students that favored boys and posited the view that this might be a "potential explanation or cause for the differential educational treatment of girls in science, which results in performance discrepancies between girls and boys" (p. 148). Such biased perceptions might not only be gender based, but in urban schools where the majority of students belong to underrepresented groups, teachers' beliefs might be influenced by stereotypical views about their students' ability in mathematics and science. Braun (1976) suggests that race and socioeconomic status are an "apparently potent source of input into teachers' expectations of their students" (p. 193). Whether stereotypical or not, teachers' views about their students are likely to be powerful determinants of their instructional decisions and of the kinds of social climate they create in their classrooms. In addition, a growing body of research on the cultural aspects of science and science teaching suggests that teachers' cultural beliefs about the diverse student populations in the science classrooms of urban schools influence their ability to provide varied and culturally responsive opportunities for such students to learn science (Atwater, 1995, 1999).

This study investigates urban science teachers' beliefs about the characteristics of their students in the context of the demands of the subject and explores teachers' reported curricular responses to those perceived student characteristics. It is recognized that investigations of beliefs pose methodological challenges. Interviews reveal only what teachers say they believe and are subject to some of the same problems of self-report instruments. Beliefs can also be inferred from teachers' descriptions of their practice and from observations of their actual practice. This study reports data gleaned by the first two methods.

## SIGNIFICANCE

The significance of this exploratory study of teachers' beliefs lies in its orientation toward praxis. It builds on the work of Lewis, Pitts, and Collins (2002) by exploring teachers' own accounts of how their beliefs about their students influence their instructional decisions. The study responds to the call by Bryan and Atwater (2002) for research that addresses high school mathematics and science teachers' "beliefs about issues of multiculturalism and its impact on science teaching and learning" (p. 834). Studies that link teachers' beliefs to their curricular practices are rare and are even more so for urban science education. It is proposed that the findings of this study, which probes teachers' accounts of their classroom practice, are followed by observational studies that examine the actual classroom practice of urban science teachers of African American students. Such studies will serve to illuminate the link between beliefs and practice. The study also has practical significance because of its potential to further illuminate the problem of the achievement gap between African American students and their majority counterparts. In addition, an understanding of teachers' beliefs about African American students' ability to achieve in science is critical to the design of science teacher education programs that prepare teachers to be culturally responsive in their classroom practice.

## METHOD

The study was designed to answer the following questions:

1. What student characteristics and what home and school conditions do urban high school science teachers believe to be necessary for high student achievement in science?
2. To what extent do urban high school teachers believe that the students whom they teach possess those characteristics?
3. What beliefs do these teachers hold about the ways in which they should adapt their teaching in response to the characteristics that they perceive their students to have?

### DESIGN

The study employed qualitative methods to explore these questions. Data were collected through the use of semistructured interviews, which allowed the researchers to explore in depth the issues raised by the participating teachers while still ensuring that all aspects of the inquiry were addressed. Each teacher was interviewed once. The interview questions were piloted with a group of four high school science teachers, who were then asked to comment on the clarity of the questions. The questions were revised in response to the interviews and comments.

### DATA COLLECTION

Eight teachers were purposefully selected from four schools in a large urban school district. Urban schools typically are located within or on the fringes of large cities; have large numbers of low-income students, many of whom are African American (Ennis, 1995); and have low levels of achievement. The schools selected for this study met all of these criteria. The percentage of African American students ranged from 70.0% to 96.9%. In none of the schools did the White population exceed 18%. The schools were selected to represent a range of achievement levels. Two were high-achieving schools and two were low-achieving schools, as evidenced by the state's school performance report achievement data (Maryland State Department of Education, 2002). Key contacts in each of the schools solicited the participation of two science teachers. Selection of the eight participants was done so that all of the science disciplines were represented. Table 1 provides profiles of the participants with respect to demographics and teaching experience.

### SEMISTRUCTURED INTERVIEW GUIDE

The purpose of the research was presented to the teachers as an investigation of factors related to student achievement in science. The interview was prefaced as follows:

> You are of course aware of the nationwide concern about student achievement in science. Several measures such as standards-based teaching have been instituted to address the problem of underachievement in science. We believe that the problem needs to be investigated from several angles and we are interested in looking at student and school characteristics as they relate to achievement. We would like to hear your views about student achievement in science.

Six preplanned questions were asked, but as is typical of interviewing techniques for qualitative research, probing questions were asked as needed to clarify participants' meanings, and where relevant, participants were asked for concrete examples to substantiate their espoused beliefs. Following is the semistructured interview guide:

1. What qualities do you think high school students need to have to do well in science?
2. What home and school conditions do you believe help students to do well in science?
3. Tell me now about your own students in this school. How would you describe your students with respect to those qualities that you say are essential for doing well in science?
4. Do you think that teachers might have to modify the prescribed curriculum in terms of how or what they teach because of the characteristics of their students?

**TABLE 1**
**Participant Profiles**

| *Pseudonym* | *Gender* | *Race* | *Age* | *School Achievement Level* | *Courses Taught* | *Years of Teaching Experience* |
|---|---|---|---|---|---|---|
| Christa | Female | White | 20-30 | High | Biology, Marine Biology | 2 |
| Karen | Female | White | 50-60 | High | Honors Biology | 27 |
| Kende | Male | Black | 40-50 | High | Physics, Chemistry | 4 |
| Stella | Female | Black | 50-60 | High | Biology 1 & 2, Anatomy & Physiology, Genetics, Microbiology | 23 |
| Jerry | Male | White | 20-30 | Low | Environmental Science | 3 |
| Marcia | Female | Black | 20-30 | Low | Biology | 2 |
| Phyllis | Female | Black | 40-50 | Low | Biology | 17 |
| Tina | Female | Black | 50-60 | Low | Physics, Principles of Technology | 29 |

5. What kinds of things do you do in your own class to adapt the curriculum to the characteristics of your students?
6. Please describe a lesson that you taught recently in which you had to make adjustments to the curriculum in response to the characteristics of your students.

### DATA ANALYSIS

All interviews were audiotaped and transcribed verbatim. Immediately after each interview, the researchers listened to the tapes together and discussed their first impressions of the issues raised by the participants. Each transcript was then independently analyzed by each of the two researchers and subsequently discussed to compare interpretations of the issues. Analysis was done using the method of constant comparative analysis that is typical of the grounded theory methodology. Each transcript was coded and the codes were clustered and combined into families. Relationships between families were sought and tested both within and across transcripts. The emerging themes were formulated in relation to the research questions.

## RESULTS

### CONDITIONS NECESSARY FOR HIGH ACHIEVEMENT IN SCIENCE

In addressing the question of the conditions for high science achievement, participants were prompted to focus on those conditions that derived from the nature of science as a school subject. The notion that science is a special subject that makes demands on learners that are different from the demands made by other subjects in the curriculum was a clear theme in all of the interviews. Science is more difficult; it demands different approaches to learning on the part of students and requires special learner characteristics. For one teacher in a high-achieving school, successful students are those who come to realize that science is more difficult.

> They realize it is difficult and if they want to do it in college they are going to have to be totally disciplined; whereas kids with other majors can go out and party and have fun and maintain a decent

> average, in math and science you can't do that. No, all the time you have to discipline and organize your time. (Karen)

In describing how science is different from other subjects, teachers referred to science as having a structure. It is made up of hierarchically organized concepts, and making connections between these concepts is important: "Science to me is a combination of concepts that somehow all intertwine into bigger concepts; as long as they can grasp the smaller ones, they may not know they are getting the bigger picture, but they are" (Marcia). The idea of science's having a structure was also implied in the insistence by one physics and chemistry teacher that problems in science have to be approached in a stepwise manner: "They have to have those steps in mind, those kind of structure to do a problem . . . ah, they have to have those structures" (Kende). Teachers also spoke often about the relationship between science and mathematics and reading. Mathematics was seen as the "gatekeeper for science" (Karen). Given the beliefs that teachers had about the nature of school science, there are a number of characteristics that students need to possess to be successful in science. These can be categorized into four groups of student characteristics: qualities of mind, attitudes, prior experiences, and home and school factors.

*Necessary qualities of mind.* With respect to qualities of mind, it appears that teachers believed that some students come to high school with "a good mind for science."

> I feel like there are some kids I can look at and say, "Yeah, this kid has a good mind for science." They have already acquired the mind for science, but I look at everybody else and say they need to acquire these skills, not that they can't—they just haven't yet. (Christa)

When prompted to explain what it means to have "a good mind for science," the teacher described such skills as the ability to formulate questions and the ability to find information. Like this teacher, every other participant elaborated a range of cognitive skills that he or she considered to be indispensable to success in science. The list includes a number of what are usually referred to as *science* *process skills*. Three of the eight teachers mentioned the skills of data interpretation and hypothesis development. These qualities of mind are, in effect, ways of thinking that science requires and that students need to have. It is interesting that Christa did not elaborate on the basis of her assessment about which students have a "good mind for science." It does not appear that it is based solely on objective criteria. The comment cited above suggests that the evaluation of whether the student has "a good mind for science" is based on external characteristics: "I feel that there are some kids I can look at and say, 'Yeah, this kid has a good mind for science.' " It would appear that some external markers, either physical or behavioral, are interpreted by this teacher as being indicative of ability to do science. Similarly, the judgment about those kids who do not possess the "good mind for science" is based on how those students look to the teacher.

*Necessary attitudes.* A range of attitudes was also identified as being necessary for success in science. Most frequently mentioned (by all eight teachers) was motivation.

> They definitely don't need ability but they need a drive, they need to want to do well. (Christa)

Speaking of a group of students who had done well in science, Tina said,

> I believe it was some kind of internal drive they had, a spirit within themselves to do well.

Other attitudes that teachers mentioned were interest in science, personal discipline, inquisitiveness, open-mindedness, and flexibility to adapt to the demands of the subject and to the physical circumstances of school, which are often less than ideal. Students also need to be accepting of criticism and to take responsibility for their own learning.

*Necessary prior experiences.* The prior experiences that students need are, for the most part, the school experiences that develop reading and mathematical skills. Students need basic science concepts and the ability to communicate in science. One of the eight teachers expressed the view that everyday experiences with nature are necessary to provide a foundation of knowledge about the world on which school science learning could be built.

*Necessary home and school factors.* Participants were asked for their views on the home and school conditions that they thought were necessary to promote high science achievement. All teachers felt that the home environment was a contributing factor in science achievement. Parents need to provide discipline and a structured environment; they need to talk to their children about school, to support the teacher, and to check homework. Participants were divided on the question of the importance of parents' own educational level or knowledge of science. One teacher expressed the view that having parents who are knowledgeable about science is "helpful but not important" (Tina), whereas another observed that the children of better educated parents do better in science, although "she hated to admit it" (Christa). When the family's economic circumstances forced students to work, it was viewed as a disadvantage.

It is interesting that this group of teachers identified very few school factors as being necessary for success in science. Three of the eight teachers (two in low-achieving schools and one in the high-achievement range) mentioned the importance of such resources as laboratory equipment and materials and felt that students would be more enthusiastic about science if these were more readily available. It was not uncommon to find teachers using their own money to purchase consumables for use in laboratory activities. One teacher in a high-achieving school felt that the school would promote higher achievement if it employed tracking as a means to "allow talent to blossom" (Christa). Three teachers believed that the school's most important role was to support teachers by promoting and enforcing standards of discipline.

## BELIEFS ABOUT THE CHARACTERISTICS OF THEIR OWN STUDENTS

Teachers were asked to describe their own students with respect to those characteristics that they had identified as being necessary for high achievement. Without exception, the teachers were overwhelmingly negative in their beliefs about their students' preparedness to do well in science. It is important to note that the negative beliefs were, in most cases, not about their ability to do science but about their disposition to do it.

> I find that more often than not my kids are so smart but just don't do anything. (Christa)

On the other hand, one teacher in a low-achieving school, in a discussion of how students acquire the qualities needed to achieve in science, described her students in these terms:

> A lot of these kids won't make it in college because they lack in intelligence, they lack the intelligence and the capabilities. (Marcia)

When queried about the need for intelligence in science relative to other areas of the curriculum, this teacher retreated to a less deterministic view and suggested that success in science is only partly due to "brightness." For most teachers, though, it was not that these urban students are incapable of doing well but that they lack a number of other characteristics needed to do well. Students were perceived as lacking the cognitive skills needed for science. They are constrained in their ability to grasp science concepts because they are concrete thinkers who are not able to engage in reflective thinking. This was mentioned by two teachers, including one from a high-achieving school, in the context of a discussion about laboratory work. Although laboratory work provides concrete experiences, it is still necessary for students to make the transition from the concrete experience to the abstract concept, and because these students are unable to do so, the benefit of the laboratory work is lost. Students were also thought to be deficient in problem-solving skills. They were seen as lacking in stamina and the ability to persevere at tasks, qualities that were thought to be needed in science more than in other disciplines. One teacher with 27 years of science teaching experience opined that there are many kids in urban schools with undiagnosed learning disabilities. In this teacher's view, increasing workplace demands that students stay in school longer exacerbates this problem:

> I think at one point in time these learning-disabled kids, I think they quit high school when they were 16, but then they would get jobs and work their way up. . . . They would be OK but now we insist that everybody finish, you can't get a decent job without an education. But we don't take into consideration how people learn differently. . . . In fact they may be smart kids but they might need one-on-one [instruction].

Teachers viewed these students as having very poor attitudes that seriously undermine their achievement in science. The lack of motivation was a consistent theme in all these interviews. Students were described as "not interested," "not trying," and "not willing." It is surprising that even in the high-achieving schools, students were perceived either as unmotivated or as motivated by such extrinsic motivators as the fear of getting poor grades rather than by an interest in science. The lack of motivation manifests itself in several ways, including not doing homework, disengagement in class, failure to take responsibility for learning, and students' failure to avail themselves of opportunities for developmental programs.

Discipline problems were also consistently cited as being responsible for underachievement:

> If a child is just bouncing off the walls, it is very hard for that student to learn. (Marcia)

Another aspect of the perceived indiscipline is the students' preoccupation with having fun. Playing video games and talking on cell phones take precedence over schoolwork.

Specific reference to racial and ethnic factors was made by two teachers. One teacher observed that African American students do not think that it is "cool" to study and that their role models are basketball and football players who had become rich without succeeding in school. Another teacher, this one in a low-achieving school, saw her students as being without Black role models in science. Furthermore, the fact that they attend a school that is known to be low achieving and is populated predominantly by African American students makes them feel that they are stereotyped as low achievers. This is demotivating to these African American students. Another teacher made reference to the fact that students who live in urban communities do not have an interest in science because nothing in their out-of-school experiences "resonates" with the science that they learn in school (Jerry).

All of these teachers perceived their students as coming to high school with inadequate prior experiences. Their mathematics skills are poor as are their science process skills. They have no knowledge of experimental design and can not interpret data. Without exception, these eight teachers described their students as having had poor preparation in the middle school grades. Following are two examples of this viewpoint:

> Something has happened to middle schools in this city. I don't know what has happened but the deterioration in the last 13 to 15 years has been phenomenal. . . . I believe the science teachers are not qualified to teach. Initially junior high school teachers were people who were certified to teach secondary science; in other words, they could teach high school and now that is not necessarily the case . . . so you have kids coming to high school knowing a tiny fraction of what they knew a decade ago. (Karen)

> So the main problem as I see it is that the students were poorly taught in the middle grades . . . the way teachers teach students to solve problems. (Kende)

Teachers were asked to comment on the extent to which the home and school conditions of their own students influenced their science achievement. The responses suggest that these teachers believed that parents were only minimally involved in their children's science learning. Seldom did parents communicate with teachers, and when they did, it was usually about custodial issues, such as student absences. With respect to school factors, these teachers felt that the schools were reasonably well resourced in spite of the fact that several of the teachers had used their own money to purchase materials for their classes. Extracurricular activities in science were seen as useful in promoting an interest in science, but the level of student engagement in these was low.

**CURRICULUM ADAPTATION**

Teachers were asked to give their views on whether the mandated curriculum should be modified in light of the characteristics of their students. They were then asked to describe any adaptations that they themselves make in either content or delivery of the curriculum in an effort to address the needs of their own students. They were prompted to give examples of these by referring to actual lessons that they had taught recently.

It is clear that the teachers recognized the need to adapt the curriculum in response to the characteristics of their students as well as to the school conditions in which they worked. They were, however, constrained by issues of accountability. One teacher in a high-achieving school claimed that she started where the curriculum started, regardless of deficiencies in prior knowledge that her students might have on entry into high school.

> We just start from the beginning. Whereas 9 years ago you could start at point A and move on, now you just have to start at the beginning. The students eventually fall into two groups: those who are motivated and those who aren't going to make it through this school. (Karen)

On the other hand, another teacher asked that the tape recorder be turned off when she described how she attempted to adapt the curriculum to the needs that she perceived her students to have. There was a clear tension between teachers' pedagogical knowledge and the accountability to the manifest curriculum to which they are held. Teachers were reluctant to say that they had departed in any way from the manifest curriculum and rejected the word *modified*.

> . . . not modified, but some things are deemphasized. (Jerry)

Analysis of teacher responses to this issue reveals that teachers modified the curriculum in response to two groups of factors. These were school conditions and learner characteristics. The school conditions that necessitated curriculum modifications were time and availability of resources. The learner characteristics were the deficiencies in prerequisite knowledge and the perceived lack of interest. In response to learner deficiencies, teachers reported slowing down the pace to ensure that students "got it," changing the sequence of topics so that more difficult topics were addressed first, spending more time on some topics than was suggested, reteaching topics that should have already been known, spending time teaching vocabulary, and increasing the number of activities done about a topic. Teachers reported attempting to reduce the level of difficulty of some topics. One physics teacher reported removing the difficult mathematics to ensure that the students' lack of mathematics skills did not hinder the learning of the science concepts. Another teacher described his method of adapting the curriculum in these words:

> There are a couple of things I do. I teach them and I know they can't go further than that. The problem is that they really can't process well enough to solve the problem, because some of the things that, if I show them, umm, how to determine acceleration or how to calculate the speed in a linear motion, I skip how to determine speed on a rotational motion. There are parts they can't follow because I only teach them speed on linear and not on rotation. All I need them to understand is the concept of speed; you are changing the distance over the time. That's all I want them to know. When it comes to the circle, it deals with angle, which is the same thing, but angles become another issue that I didn't teach them. I skip that part, for example. (Kende)

Teachers made judgments about whether students were likely to use the science in the future and taught accordingly. Some students were judged as never taking another science course so, for example, they would not be required to learn the names of the intermediate compounds in the Krebs cycle because it is pointless to "teach them something they will never use" (Phyllis). If students were not science majors, then the depth of treatment of concepts was reduced and the "more technical stuff" was omitted.

When students were judged to be lacking in motivation or interest in science, teachers attempted to engage them by contextualizing the science in experiences that were familiar to them. Real-life application of the science concepts was the strategy used. One teacher reported helping the students to understand principles of heat transfer by referring to temperature differences between the basement and other parts of the house. Motivation was deemed by these teachers to be an important determinant of their students' success in science, and teachers sought to foster this by making the science more relevant.

Time was described as a major constraint for these teachers. A physics teacher complained that the physics curriculum needed 3 times as much time as was allotted to it. Teachers who adapted to their students' needs by slowing down the pace of teaching often ran out of time, and some topics were not taught. Teachers made judgments about what could be omitted and taught the more difficult or important topics first. When laboratory resources were in short supply or lacking, teachers reported using "informal labs and simulations."

Views about the curriculum varied depending on whether the teacher taught in a high- or low-achieving school. Teachers in the low-achieving schools felt that there was a mismatch between the prior experiences of their students and the demands of the high school science curriculum. Students' middle school science experiences had not prepared them for high school science, and their out-of-school experiences worked against high achievement in science. Teachers in the high-achieving schools, on the other hand, felt that the curriculum was not challenging and that unless the students received some enrichment, they would not be competitive in college. Furthermore, in that school system, there was no honors curriculum in at least one of the sciences. One teacher felt strongly that unless high school students were streamed by ability, "talent would never blossom" because the presence of so many ill-prepared or learning-disabled students in the classes only served to "dumb down" the curriculum (Karen).

## DISCUSSION

This study of teachers' beliefs about urban high school students' ability in science was premised on a notion of beliefs as encompassing a range of teacher dispositions, which influence their classroom practices—both their instructional practices and their interactions with students. Its purpose was to uncover these beliefs and the links that teachers make between their beliefs and their decisions and practices. The findings of this study could be useful for formulating questions to guide observational studies that could provide deeper understandings than we now have of the curricular experiences of urban science students.

**A DEFICIT MODEL**

It is clear that, for the most part, these teachers employed what has been described as a deficit model for understanding the problems that urban children face with respect to school achievement. These teachers viewed science as difficult, as more demanding than other subjects, and as requiring students with special characteristics. It is more difficult than other subjects, and only those who recognize that and who naturally have or acquire a good "science mind" can be successful. This leads one to wonder whether these teachers subscribe to a somewhat elitist view of science, which, although not necessarily motivated by an intention to be exclusive, might in fact function to exclude these students from full access to science.

Teachers' explicitly stated beliefs about their students, with respect to the characteristics needed for high achievement in science, reveal that they viewed the students as deficient in many of the skills, attitudes, and prior knowledge that are required. The students lack motivation, are not interested, and often do not comply with the teachers' demands. Teachers in this study are not unique in holding these beliefs. Gross (1993) reported that teachers found that Black students "did not come to their classes prepared to work or in the proper frame of mind to attend fully to instruction" (p. 281).

These teachers did not believe that their students measured up to the high intellectual and attitudinal demands of science. The deficit model used to explain the low levels of school achievement of underrepresented groups absolves the school or the society of any complicity in the students' underachievement and places the blame on the students, their parents, and their communities. In this view, as is the case with the teachers in this study, the students are seen as not having what it takes to succeed. None of the teachers in this group applied any sociocultural lenses to their characterizations of their students' qualities or behaviors. Their characterizations reflected widely held stereotypes that charge African American students with a lack of interest in academics and low performance in school subjects, especially mathematics and science. Steele (1999) posited the notion of "stereotype threat," which suggests that members of stereotyped groups experience levels of anxiety that serve to depress their performance when they are placed in situations where the stereotype operates. The resulting underachievement serves to confirm the stereotype, creating a self-perpetuating cycle. Ogbu and Simmons's (1998) cultural-ecological theory is another sociocultural lens that provides for more insightful description of students' characteristics than the deficit model subscribed to by the teachers in this study. Ogbu and Simmons suggest that the apparent lack of interest in school and the poor work ethic that Black students are thought to display are responses to the sociohistorically determined patterns of dominance in the wider society in which teachers and students live. The intersection of the cultural framework of a predominantly White teaching profession and that of Black students often mirrors the conflicts that exist in society due to differences in social positioning between majority and underrepresented groups. Through this lens, students' disengagement from academics might be construed not as the result of intellectual deficiency but as the result of feelings of alienation. Ennis and McCauley (2002) suggest that the lack of motivation, the failure to comply with school demands, and the lack of engagement with learning, all of which were described by teachers in this study, are evidence of a lack of trust in the educational system on the part of urban children. It is interesting to note that Atwater, Wiggins, and Gardner (1995) found that those urban African American middle school students who had negative attitudes to science had negative attitudes to science teachers, the science curriculum, the school climate, and the physical environment of the school.

With respect to teachers' beliefs about their students' parents, the deficit model was also apparent. Atwater et al. (1995) also noted the influence of parents' educational level on student achievement. In this study, the assertion by one teacher that student achievement in science correlates with parental educational level is supported by the work of Entwisle and Alexander (1988). It is possible that the lack of parental involvement in the academic lives of urban children, as perceived by the teachers in this study, might have more to do with feelings of disempowerment, engendered by parents' own poor educational backgrounds, than with a lack of interest in their children's education. It seems evident that the teachers in this study were unaware of other, more culturally sensitive ways of viewing their students, and their beliefs about their students' characteristics seemed to reflect the racial stereotypes prevalent in the society. The literature cited earlier, on the impact of teacher beliefs on student outcomes, suggests that these beliefs about students are likely to have a profound effect on teachers' instructional decisions.

### CURRICULUM IMPLICATIONS

The curricular responses of the teachers in this study to their beliefs about the characteristics of their students included changes in sequence and pace, deemphasizing of some topics, and simplifying of others. Gess-Newsome and Lederman (1995) noted that one of the teachers in their study engaged in similar kinds of adaptation of a biology curriculum in response to that teacher's perceptions about the students' psychological states. It should be noted, however, that Gess-Newsome and Lederman's study was not conducted in an urban setting. It is possible that these adaptations in fact amount to a watering down of the science curriculum. The tendency on the part of teachers to eliminate the more complex concepts, to deemphasize some topics because they did not believe their students would take another science class, and to reduce the depth of coverage of others might well be an indication that these students were being offered a "pedagogy of poverty" (Haberman, 1991). Indeed, if the students are seen as deficient, then reducing the complexity of the science content is the appropriate response. Like the preservice teachers in the Lewis et al. (2002) study, these teachers did not appear to have any understanding of culturally relevant science teaching. They did not conceive of their students as possibly bringing to the science classroom a set of cultural meanings and understandings that might necessitate changes in pedagogy and that might indeed become a valued part of the interaction that is the essence of curriculum. Culturally relevant teaching is teaching that is based on the principle of leveraging the cultural frameworks that children bring to school to promote learning that is meaningful and that leaves them feeling valued and respected. It has implications for all aspects of schooling, including the organization of schools, classroom norms and values, the selection of content, and the design of learning experiences.

The fact that teachers were reluctant to report any adaptation at all suggests that they hold a view of curriculum as static and outside their control. This is in contrast to a view of the curriculum as dynamic interaction of which both teachers and students have ownership. One teacher with 27 years of teaching experience lamented her lack of freedom to take her students' prior knowledge as the starting point for her teaching and admonished that the current emphasis on testing in the school system will not "fix what is wrong with science education."

In sum, the urban high school science teachers who participated in this study held the view that their students were, for the most part, ill-prepared for high school science and lacked the skills, attitudes, interest, and motivation needed to attain a high level of achievement in science. The finding that teachers in this study did not hold high expectations for their students' success is particularly troubling in light of Casteel's (1997) research, which suggests that for Black students, teachers' expectations have a greater influence on their learning outcomes than is the case for White students. On their part, the teachers were unaware of the ways of making the curriculum culturally relevant and reported only making adaptations that were accommodations to the deficiencies they perceived in their students. The implications of these findings are that urban high school students might in fact be experiencing a curriculum that is not culturally relevant, is alienating, and does not promote their engagement with the subject. If these students are then assessed by the same measures as their counterparts in nonurban settings, then the much-publicized achievement gap between urban and nonurban students in science comes as no surprise.

It is important to note that all of these teachers expressed deep concern about the academic progress of their students. They obviously cared about their welfare and wanted to be effective in teaching them science. It appears, however, that they had little understanding about how to teach science in ways that are culturally relevant. The implications for science teacher education programs, in both preservice and professional development, are obvious. This spirit of caring for students is the capital on which effective professional development that sensitizes teachers to the principles and practices of culturally relevant teaching must be built. If teachers are to be able to make the change toward more culturally sensitive strategies, they must first understand the ways in which their teaching has been culturally insensitive and then confront the beliefs that underlie their practice.

Perhaps the most important finding of this study is that these urban students are perceived by their teachers as lacking the necessary qualities for high achievement in science and that these beliefs might be influencing the teachers' instructional decisions in ways that limit the students' opportunity to learn science. The fact that 95% of these students are African American, as is the case with many urban schools, suggests a possible reason for the persistent underachievement of urban students in science. The extent to which this is the case is best determined by observational studies that examine the curricular experiences of urban children and that explore more directly the link between teachers' beliefs and their classroom practice in science.

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