

Beliefs and Reported Science Teaching Practices of Elementary and Middle School Teacher Education Majors from A Historically Black College/University and a Predominately White College/University

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Abstract

Project Nexus, an undergraduate science teacher preparation program, was designed to develop and test a science teacher professional development model that prepares, supports, and sustains upper elementary and middle level specialist science teachers. Of particular interest was the recruitment of a diverse teaching force, particularly African American. We implemented our model at two types of universities: a Historically Black College/University [HBCU], and a Predominately White University/College [PWUC]. Of focus in this year 1 study of the program was the need to collect and analyzing baseline data of all the previous year's graduates of the two institution's undergraduate elementary/middle school teacher preparation programs. Determining the baseline data would provide an essential measure from which to compare impact of the program after five years of implementation. We administered an established instrument, "New Teachers' Beliefs and Practices of Science." We compared our sample's responses (closed and open-items) by institution and with a sample of national teachers' responses. Findings indicated that along all statements the 2005 graduates reported that they are more likely to use practices, which are recommended by national latest reform documents (AAAS, 1993, National Academies, 2006, NRC, 1996) than the national teachers' group, with higher percentages in the PWUC than in the HBCU. Interesting, however, on the open-ended item we found that more HBCU graduates thought it was very important to be taught in a culturally responsive manner than did the PWUC graduates. Implications for teacher preparation were discussed.

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Introduction

This study reports baseline data as a way to document treatment effect in a teacher preparation innovation project (Project Nexus [PN], the Maryland Science Teacher Professional Continuum for Upper Elementary/Middle Level Grades). The purpose for this study was to collect information on the number and characteristics of graduates of

two types of teacher preparation programs, Historically Black College/University [HBCU] and a Predominately White College/University [PWCU]. We compared the results between institutions and with a larger national sample.

A primary measure of success for our study will consist of documenting in Project Nexus how many interns are recruited, prepared, and then teach *Standards*-based science to upper level elementary students. The total impact of the innovation in Project Nexus (PN) will be obtained by comparing current baseline data with data collected at the end of five years of project activities. Of interest to determine to what extent the elementary education teacher programs at the HBCU and the PWCU are able to recruit and prepare new teachers who take upper elementary/middle level science teaching positions, and teach in a standards-based manner, particularly those from currently underrepresented groups.

Since our aim is to make empirically supported recommendations for science teacher education, we will base our arguments of the impact of the project's activities on the comparison of the baseline data with the final data. The two areas measured are the new graduate's beliefs (a) of science and science teaching and (b) of the role of their ethnicity/race in their career decision to become teachers.

We report on our baseline data that was gathered through application of survey methodology. The instrument used was "New Teachers' Beliefs and Practices of Science" (McGinnis & Parker, 2001).

Rationale for the Innovation

A current need in science education is to increase the number of qualified upper elementary/middle school science teachers, particularly those from typically underrepresented groups. To do so, major goals for teacher preparation is to: (a) increase the number of elementary teacher education majors who concentrate in science; (b). recruit students from diverse backgrounds, particularly African Americans; (c). focus on how to teach all populations, commonly referred to as "teaching for all" (Fensham, 1985).

Bransford, Brown, and Cocking (2000) use the term "learner centered" to refer to environments that pay careful attention to the knowledge, skills, attitudes, and beliefs that learners bring to the education setting. The term includes teaching practices that have been called "culturally responsive," "culturally appropriate," "culturally compatible" and "culturally relevant". (p. 134). Teaching for all strategies includes the acknowledgment that learners have developed preferences on how to engage with content: some students prefer audio input; some prefer video input, others prefer seeing the material in writing, writing down the material or when they verbalize the material aloud in their own words (Suinn, 1999).

PN is designed to focus on "teaching for all" strategies that are used broadly in the science and the method courses (see context of the study). In addition, PN focuses on

improving the science content background of elementary education majors and preparing them to see relationships between science and mathematics. The focus on interdisciplinary teaching that stress the importance of connections between science and mathematics aligns with the recent call by the National Academies (2006) in *Rising Above The Gathering Storm: Energizing And Employing America For A Brighter Economic Future*“ to recruit, educate, and retain excellent K-12 teachers who fundamentally understand biology, chemistry, physics, engineering and mathematics” (p. 5-2). The participants in Project Nexus are from diverse populations, including elementary teacher education majors, with a special interest on those from traditionally underrepresented groups such as African Americans, practicing public school mentor teachers, and informal science education adult leaders.

Context of the Study

PN is designed to develop and test a science teacher professional development model that prepares, supports and sustains upper elementary and middle level specialist science teachers. PN is a 5-year project supported by the National Science Foundation Teacher Professional Continuum program. The experienced project leadership includes experts in science content, science methods, and informal science education.

Since a significant focus in PN (in regards to recruitment, preparation, and support) is on the ethnicity/race of the prospective teachers, we implement our model at two types of universities. The types of universities consist of a Historically Black College/University [HBCU] and a Predominately White College/University [PWCU] that is a Research University, Very High (Carnegie Rankings System). The representative HBCU University in the first year of the project was Bowie State University [BSU] (2005 elementary education graduates: 63% African-American; 32% White); however, due to an opportunity in the second year of the project to increase the samples size by switching to a larger HBCU institution, we replaced it with a different HBCU university, Florida A&M University [FAMU]. The representative PWCU is the University of Maryland, College Park [UMD] (2005 elementary education graduates: 81% White; 6% African-American).

Markedly, the percentages of African American elementary teacher education majors were lower than those of the general undergraduate African American populations of both institutions (e.g., UMD’s African American population was 12%).

Innovations in Project Nexus

PN is a comprehensive research study that will examine four components (detailed below) in a step-by-step fashion as our interns experience them. [For additional information on the project, please visit the project’s web site, www.projectnexus.umd.edu].

1. The transformed science content course includes both lecture and lab. It is taught in the College of Chemical and Life Sciences. The lecture part of the

course is designed to enable students to develop life long learning skills, an appreciation and understanding of science, and the ability to explain science to others. The course uses a variety of teaching strategies applicable to both science and non-science courses from the elementary through college level. It is based on a 12-part video series *Unseen Life on Earth*. The videos are used in the course in an interactive manner, after each section of the video there are small group and whole class discussions. The instructor asks questions and encourages student questions. An important goal of the course is to model teaching for all (for different students with different backgrounds and differing preferences on how to engage with science content) with the hope that students who pursue teaching as a career will learn how to teach effectively all learners. In the laboratory section, students design experiments, conduct research, discuss how science is used to solve problems, and get hands-on experience with the world of microbiology through the lens of their own personal interests.

2. The representative informal science entity is Hands On Science Education, Inc., [HOSO] a non-profit organization that offers informal afterschool science education classes for elementary students throughout the US and in several other countries. HOSO was established in 1980 to provide a regular informal science option for pre-school and elementary aged learners. Its activities are consistent with the *National Science Education Standards* (National Research Council, 1996). The informal science education entity is a community-based program that offers afterschool science education courses (1 hour each for 8 sessions). A trained adult leader (usually a parent) leads sessions of up to 11 students in small group activities that are engaging and hands-on/minds-on. Adult leaders receive a full day of training that consists of an orientation to the HOSO curricular materials, including pedagogical guidance, and to an informal science philosophy of teaching and learning science.

3. The transformative science methods course is performance-based. It is taught in the College of Education. Its goals and outcomes align with the standards-based recommendations found in the *National Science Education Standards* (1996) and endorsed by the program's sponsored accreditation association (ACEI/NCATE). The instructor interweaves technology and mathematics throughout the student-centered course. Data management and analysis are emphasized. A commitment is made to represent high quality science instruction as inquiry-based and for all. As such, lecture is diminished and culturally responsive strategies are demonstrated and taught. The instructor uses the Socratic method in both small group and whole class discussions. Interns engage regularly in small cooperative learning groups to answer and pose problems in science that take into account children's thinking. The goal is to utilize such knowledge in instructional design and practice. Interns design both short term (daily) and long term (extended science investigations) learning experiences that are conducted with young learners in an accompanying field experience (Professional Development Schools (PDS) network). Peer coaching is utilized throughout, and ongoing reflection by the interns is required. Linkages to informal science education are encouraged.

4. Field experience in the teacher preparation program is situated in a Professional Development School (PDS) context. Interns in the final year of their program are placed during the fall semester in a participating PDS elementary school. During the fall semester, the interns spend two full days a week in their PDS placement. In addition, they also spend three full weeks (Monday to Friday) in their placements, in August before the young students begin the school year, in mid-October, and in mid-December. The purpose being to obtain a more comprehensive view of schooling from the mentor teacher and young learners perspectives. During their school placements, the interns conduct disciplinary crafted core assignments with the young learners that are assessed by both university personnel and school-based personnel. During the spring semester, the interns spend five days a week in their PDS placements, and they progressively take over full instruction of the young learners. The interns are assessed periodically by university and school-based personnel and by review of a comprehensive professional portfolio at the end of the internship.

Literature Review

Current recommendations made by prominent teacher educators such as Cochran-Smith, and Zeichner (2006) and Darling-Hammond (2000) are for teacher preparation programs to pay attention to the demographic profile of their interns and graduates. Concomitantly, they stress the need for teacher preparation programs to place special attention on teaching instructional strategies that take in account cultural differences of young learners. What follows is a concise literature review structured along three lines relevant to our baseline study: teachers' demographic profile; reforms in teacher preparation programs; and teachers' beliefs towards science and science teaching.

Teachers' Demographic Profile

PN highlights the importance of recruiting underrepresented populations (African-American candidates) for teacher preparation programs. Therefore we decided that we needed to collect baseline data that identified the type of sample at the two differing teacher preparation institutions in the project. The undergraduates at both the HBCU and the PWCU institutions earned the degree of Bachelor of Arts in elementary education. The undergraduates who were enrolled in the teacher education programs did not hold any other post-secondary degrees when they were recruited.

Survey methodology is designed to accomplish this task efficiently (Smith & Glass, 1987). The baseline data then could be compared later to assess the impact of the project in targeted areas. Currently, although the student population is increasingly diverse, 1999-2000 data indicate that US "public school teachers were predominantly White, non-Hispanic (84%). Of the remaining proportion, 7.8% were African-American, 5.7% Hispanic, 1.6% Asian American, and 0.8% Native American" (Zumwalt & Craig, 2006, p. 114).

As articulated by the National Research Council (NRC, 2002) and the Education Commission of the States (Allen, 2003) there is an imperative need for those involved in science teacher education to report empirically based research. More specifically, as articulated by Zeichner (2005), there is a concomitant call for research in teacher education to examine how to prepare teachers successfully to teach the diverse students who are in US public schools and how to recruit a diverse teaching force.

In 1996, Lewis pointed out that proportionally there were many more students of color (31%) than teachers of color in the teaching force (13%). More recent data on US school populations as reported by Guarino, Santibanez, and Daley (2006) shows that by 2000, 39% of students were members of minority groups (17% Hispanic, 17% Black, and 5% were members of other racial/ethnic group). Linda Darling-Hammond (2000) and others such as Kirby, Berends, and Naftel (1999) have chided schools for poor recruiting strategies and for schools of education for not responding to market pressures quickly enough to remedy this imbalance in the ethnic/racial backgrounds of students and their teachers.

Historically, teaching has been a popular career among African-Americans. After World War II, 79% of black female college graduates were employed as teachers. As other career opportunities became available, however, by the mid-1980s, this percentage fell to 23% and the proportion of minority teachers in general had dropped considerably. As result of this negative trend in the diversity of the teaching staff, the gap of ethnic background representation (particularly impacting students of color) between US students and their teachers is large and widening.

Reforms in Teacher Preparation Programs

In many nations, science education is currently going through a process of change (van Driel, Beijaard, & Verloop, 2001). The reform efforts in different countries (e.g., in the USA - AAAS, 1993; NRC, 1996; in United Kingdom - *Beyond 2000*, Millar, & Osborne, 1998) share important characteristics related to dissatisfaction with how science traditionally is taught. To change the status quo, efforts in the last decade have focused on the professionalization of teaching, under the assumption that upgrading the profession will increase teachers' commitment and motivation. It is assumed that these changes in teacher preparation and professional development results in better teaching, as defined by the major reform documents, and improved student learning (National Science Foundation, 1998).

According to this scenario the literature suggests that teacher professionalization should move forward on two main levels:

(1) *Reforms in teacher preparation programs* (Adamson, Banks, Burtch, Cox, Judson, Turely, Benford, & Lawson, 2003). Such reforms have different foci, from developing extended graduate level teaching programs, with emphasis on additional content courses, to programs with emphasis on pedagogical aspects such as promoting innovative teaching approaches (i.e., active learning teaching approaches).

(2) *Professional development services to support teachers that begin through the inductive years, advanced to the early and mid-career stage, and culminates in the master teacher or late career phase* (Luft, Roehrig, & Patterson, 2003). This effort assumes that learning to teach is a developmental process during which teachers progressively refine their beliefs and practices during their years of practice (Yerrick, Parke, & Nugent, 1997).

PN is located primarily under the first type of reform since it is concerned with formulating new content and pedagogy courses that modeled inquiry-based and interdisciplinary approaches. The current approaches to reform in science teacher preparation programs, and in service teacher professional development programs have led to unprecedented interest in research on the efficacy of such reforms (Simmons, et al., 1999). Gallagher and Richmond (1999) stated, “Despite the seeming efficacy of the goals and claims that underlie current reform, there has been little formal, scholarly effort on the part of the science [education] community to ground the reform carefully in research” (p. 753). One way to evaluate and understand the role of teachers with respect to educational reform is to examine their beliefs and views towards the discipline that they teach as well as towards teaching and learning (Tobin & McRobbie, 1996).

Teachers’ Beliefs Towards Science and Science Teaching

In the design of our baseline study we focused primarily on the teachers’ beliefs towards science and science teaching. A variety of terms are used to define teacher beliefs. These include preconceptions, implicit theories, and orientations. Research articles include discussions from psychological and cognitive science perspectives by Abelson (1979) and Nespor (1987), as well as research reviews by Kagan (1992) and Pajares (1992); and the role of attitudes and beliefs in learning to teach by Richardson (1996). This literature contributes to a consensus that beliefs are part of a group of constructs that describe the structure and content of a person’s thinking and are presumed to drive her/his actions (Bryan & Atwater, 2002). Whatever the definition, it is generally agreed that what teachers believe (as it relates to their philosophy of teaching, their role within that process, the role and expectations of the students for learning, and the role of the school, science curricula, and context for instruction) will be an essential foundation for what occurs in the classroom (Blake, 2002).

Currently, there is substantial evidence that teachers’ performances at school are influenced by their beliefs about teaching and learning (Pajares, 1992; Richardson, 1996; Wilkins, 2004). Nespor (1987) argues that beliefs are structured from previous events and experiences. A teacher’s past events create “guiding images” that act as a filter for new information. A belief structure created from an earlier experience may also be resilient enough to become the standard to which newer information is compared. For example, if a teacher changes conceptions of what quality teaching is, from a traditional whole group approach to a cooperative learning orientation, all new information about practice will be filtered through the cooperative learning belief structure (Blake, 2002).

Bryan & Atwater (2002) demonstrate in their research on teacher thinking that teachers' beliefs about the teaching-learning process play a significant role in determining the nature of teachers' purposes in the classroom and directly affect many aspects of their professional work, including lesson planning, assessment, and evaluation. In addition, teachers' beliefs influence their decision-making during classroom interactions with students (Leinhardt, 1990).

Bybee (1993) maintained that teachers are the "change agents" of educational reform and that teachers' beliefs must not be ignored. According to Bandura (1986), beliefs are the best indicators of the decisions people make throughout their lives. Clusters of beliefs form attitudes and action agendas (Ajzen, 1985; Pajaras, 1992). Theory holds that people tend to act according to their beliefs. More accurately then, as Haney et al. (2002) suggest, the beliefs that teachers hold regarding science reform ideas are truly at the core of educational change.

While certain belief systems are promoted in teacher education programs, the actual beliefs teachers bringing into their classroom might not be exactly the same. In Cobern and Loving's (2002) survey of "Thinking about Science," they found many of their sample's preservice teachers did not believe women and minorities were as welcome as White males in the scientific community. McIntosh & Norwood (2004) sampled only minority teachers' responses to certification examination questions. Their analysis of the "Teacher Belief Survey" revealed that the belief systems of African-American preservice teachers were teacher-oriented rather than student-oriented. These two studies suggest that teacher preparation programs need to take into account other factors outside of what was surveyed that might influence teachers' beliefs about teaching practice and student outcomes.

Tosun (2000) measured preservice elementary education students' beliefs about teaching before and after a discipline-integrated methods course. The instrument used was the "Science Teaching Efficacy Belief Instrument." Tosun found that the methods course played a limited role in improving the science teaching self-efficacy. Earlier, Stevens and Wenner (1996) used the "Science Teaching Efficacy Belief Instrument" to compare preservice teachers' beliefs with their knowledge of science. While the elementary teacher education students showed relatively high confidence in teaching science, their general understanding of the content knowledge was insufficient to support their teaching. Measuring preservice teachers' beliefs at different stages in the teacher preparation programs may reflect a clearer picture of the changing process of attitudes and beliefs over time.

Methodology

Instrumentation

Survey methodology was used in this study to establish baseline data. Survey methodology is a recognized "venerable tradition" (p. 225) in social science research when the goal is to collect and report characteristic data for an identified sample (Smith

& Glass, 1987). In this study we used an established instrument that was crafted for previous studies and was used to compare between groups of UMD graduate students, The Maryland Collaborative for Teacher Preparation (MCTP), and a national sample of teachers (National Science Foundation, 1998; McGinnis, 2002; McGinnis & Marbach-Ad, 2007; Marbach-Ad & McGinnis, 2008). The “MCTP beliefs and practices in science and mathematics” instrument aimed to measure the constructs of interest of the program’s graduates.

To craft the “MCTP teacher’s beliefs and practices in mathematics and science” instrument we searched existing reported survey items that practicing teachers had previously responded¹. This strategy required us to examine the literature for accepted and reported surveys that measured practicing teachers’ constructs that we targeted and then develop a new survey, consisting primarily of items taken verbatim from those reported surveys.

We found success in our search when we inspected survey data reported in the National Science Board’s 1998 Science & Engineering Indicators (NSF, 1998). Specifically, we found existing valid and reliable surveys that measured: *Teacher beliefs about the nature and teaching of mathematics and science: 1994-95* [46] ; *Teacher perceptions of student skills required for success in mathematics and science: 1994-95* [47]; *Teachers’ knowledge of the standards: 1994-1995* [48]; *Percentage of science and mathematics teachers implementing reform activities: 1996* [49-50]. Upon inspection, we determined that these instruments were based on items used in the TIMSS study.

From these surveys we crafted a new 51-item survey, “MCTP teachers’ actions and beliefs of mathematics and science,” consisting of 44 previously administered items taken from those reported surveys. We added two items to our survey that related to a unique aspect of the MCTP, making connections between mathematics and science in instructional practice. We added another item that asked about the teacher’s familiarity with the National Science Education Standards. We also included 4 items that asked background information.

In the current study we eliminated the questions about teachers’ actions and beliefs of mathematics, since the focus of the study is on science teacher preparation program. To establish face validity of our “New Teachers Beliefs And Practices Of Science” instrument (i.e., that there existed a connection between the surface features of the instrument’s content and the theoretical construct, Smith & Glass, 1987), we provided for inspection the draft instrument to a sample of science content experts and a sample of science pedagogy experts (we reported on its reliability in McGinnis & Parker, 2001).

Our theoretical constructs consisted of beliefs about the nature and teaching of science. Namely, we sought to determine if the graduates held beliefs about science content that aligned with a traditional view of science as a static and codified body of knowledge or a view of the discipline as a dynamic way of knowing driven by inquiry. Regarding the teaching of science, our aim was to measure if our graduates held beliefs

¹ Material drawn from McGinnis & Marbach-ad, 2007.

about the teaching of science that were teacher-centered or learner-centered, as characterized by passive learning (lecture) or active learning (problem solving), respectively. The surface content of the instrument consisted of the items selected from a limited number of existing instruments as well as two new items that measured beliefs about subject matter integration and knowledge about the major standards documents. The content specialists included a chemistry professor, a physics professor, and a life science professor and three doctoral students, one from each science discipline respectively. The pedagogy experts included two associate professors of science methods and two doctoral students in science methods. The result of the inspection by our sample strongly supported the face validity of our instrument.

The constructs we measured using Likert scale for five level responses were “Teachers’ beliefs about science (Items 7-15),” “Teachers’ perceptions about student success in science (Items 16-21),” “Teachers’ knowledge of the science standards” (Items 22, 23), “Teachers’ intentions about implementing reform activities in science classes (Items 24-30),” and 6 items that asked for background information (Items 1-6). Innovatively, we added an open-ended question that asked our participants to respond to how they thought their career decision might have been influenced by their ethnicity/race.

Instrument Administration

We analyzed the survey responses in different ways – using t-test and chi square analyses, and using analysis for the whole survey and for separate group of questions. We decided that due to the small sample and the large variability between the different items in the survey that it was most appropriate to only compare percentages for each of the items.

For the open ended question, “In reflecting on what influenced you to pursue a career that involves significant science teaching responsibilities, how was your decision affected by consideration of your ethnicity and/or gender?” we used a modified content analysis strategy that did not engage in hypothesis testing. Classical content analysis comprises techniques for reducing texts to a unit-by-variable matrix and analyzing that matrix qualitatively to test hypothesis (Ryan & Bernard, 2000).

Sample

During Spring 2006, we administered the survey to our recent graduates from the elementary education teacher preparation programs at UMD and BSU (certification levels, grades 1 to 8). Due to unexpected reasons we had to move in the second year of the program to FAMU, a different HBCU institute. As earlier reported, this change resulted in an opportunity to increase our sample size for the HBCU. It also brought us some challenges. As an opportunity FAMU offered us a much larger elementary teacher education teacher preparation program, which helped to augment our original sample size from the HBCU. The challenge was that we could only gather information from FAMU intern students enrolled in their upper level undergraduate teacher preparation program and not from those who had graduated.

Nevertheless, we believe that this augmented baseline data set is an acceptable good basis for comparison, since it is derived from similar populations and it reflects teacher education interns who are benefiting from reforms that have been recommended in the last few years. We also decided to compare our recent baseline data with a larger, sample of practicing elementary and middle school science teachers (national sample) since graduates from the PWCU and the HBCU elementary programs were certified to teach grades 1 to 8.

The 1995-6 national data were collected by administration of valid and reliable survey instruments (NSB-1998). We used relevant sections of those instruments verbatim as the platform for our researcher-crafted survey with the goal of comparison of the different populations (HBCU, PWCU and the national sample) (McGinnis & Parker, 2001; McGinnis & Marbach-Ad, 2007; Marbach-Ad & McGinnis, 2008).

In late fall 2005, the survey instrument was administered electronically by website, delivered e-mail and as a hard copy to our BSU and UMD teacher education graduates from 2005. The response rate for this administration was for UMD - 60 out of 116 for BSU - 8 out of 19. While ideally a higher response rate from the sample would be desired (particularly for our participating HBCU institution, BSU), it should be acknowledged that arguably this is an acceptable level of response for this difficult to locate and measure population (first-year teachers). We attribute the high level of response to the strategies for increasing return rates to mail-in surveys suggested by Dillman (1978). Strategies included offering an inducement (a lottery with 5 randomly selected winners of prizes) and repeated invitations by e-mail and by mail. In fall, 2006, we administered and collected hard copy surveys from 28 FAMU interns randomly selected from a cohort of upper level education majors. Table I shows the background information of the respondents. The national sample was different for each section of the survey (see Results).

Table I
Demographic distribution of the baseline study participants

	UMD (PWCU) Percentage of graduates (N=60)	BSU (HBCU) Percentage of graduates (N=8)	FAMU (HBCU) Percentage of Interns (N=28)
Grade level taught			
Lower elementary school	51	25	75
Upper elementary school	27	50	21
Middle school	5	12.5	4
Not teaching	17	12.5	
Gender			
Females	83	75	89
Males	17	25	11
Age			
Between 20 to 25	88	75	68
Between 26 to 30	5	-	11

Above 30	7	25	21
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Ethnicity			
African-American	8	62.5	93
Asian	10	-	
Caucasian	75	37.5	
Hispanic	3.5	-	7
Others	3.5	-	
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Results

We report our findings according to the four sections in the survey.

1. *Teachers' beliefs about the nature and teaching of science.* In this section teachers were asked to rate on a scale from 1 to 5 (1= strongly disagree...5=strongly agree) 7 statements concerning their beliefs about the nature and teaching of science (Appendix, 7-15). Items 14, 15 were opposite statements to items 10, and 13 to assure students' reliable response. Table II shows the participants responses. The percentages in this table reflect the combined proportion of teachers who either agree or strongly agree with the statements. The national sample group, in this section, was science eighth grade teachers (n=232) who were surveyed in 1995 as part of the Third International Mathematics and Science Study.

Overall, the recent BSU graduates and FAMU interns were *less likely to believe*: science is primarily a formal way of representing the real world (48.3% UMD; 25% BSU; 42.8% FAMU – 84.3% National) and that it is primarily a practical and structured guide for addressing real situations (55% UMD; 62.5% BSU; 46.4% FAMU – 88% National). Interestingly, the FAMU interns were *more likely to believe*: “some students have a natural talent for science and others do not (62% National; 46.7% UMD; 37.5% BSU – 85.7% FAMU) and “It is important for teachers to give students prescriptive and sequential directions for science experiments” (75.8% National; 70% UMD; 75% BSU – 92.9% FAMU). For the rest of the statements there was a similar response rate for all groups.

Table II

Comparison between the groups' (2005 graduates, the national sample and the FAMU interns) responses, to the "Teachers' beliefs about the nature and teaching of science" section, by percentage responding "Agree" and "Strongly agree."

Item	National	2005 Graduates:		HBCU ³ interns
		PWCU ¹	HBCU ²	
7. Science is primarily a formal way of representing the real world.	84.3%	48.3%	25%	42.8%
8. Science is primarily a practical and structured guide for addressing real situations.	88.0%	55%	62.5%	46.4%
9. Some students have a natural talent for science and others do not.	62.0%	46.7%	37.5%	85.7%
10. A liking for and understanding of students are essential for teaching science.	89.6%	80%	87.5%	67.8%
11. It is important for teachers to give students prescriptive and sequential directions for science experiments.	75.8%	70%	75%	92.9%
12. Focusing on rules is a bad idea. It gives students the impression that the sciences are a set of procedures to be memorized.	32.0%	26.7%	12.5%	12.5%
13. If students get into debates in class about ideas or procedures covering the sciences, it can harm their learning.	2.8%	0%	0%	0%

¹ University of Maryland ² Bowie State University ³ Florida A&M University

2. *Teachers' perceptions about students' skills required for success in science.* In this section teachers were asked to rate on a scale from 1 to 5 (1 = Not at all...5 = Extremely) the importance of particular kinds of skills for success in the discipline. These skills have elements ranging from remembering through understanding to thinking in sequential manner. Table III shows the participants responses. The percentages in this table were rounded and they reflect the percentage of teachers who choose the categories "Moderately" or "Extremely." The national sample group, in this section, was eighth grade teachers (232) who surveyed in 1995 as part of the Third International Mathematics and Science Study.

Table III

Comparison between the groups' (2005 graduates, the national sample and the FAMU interns) responses to the "Teachers' perceptions about students' skills required for success in science" section, by percentage responding "Moderately" or "Extremely."

How important do you think it is for students:	National	2005 Graduates:		HBCU ³ interns
		PWCU ¹	HBCU ²	
16. ...to remember formulas and procedures?	25.5%	40%	50%	60.7%
17. ...to think in sequential manner?	79.6%	55%	75%	53.6%
18. ...to understand concepts?	84%	85%	87.5%	96.4%
19. ...to be taught in a culturally responsive manner?	-	61.6%	87.5%	50%
20. ...to understand science use in the real world?	79.2%	80%	87.5%	75%
21. ...to support their explanations/arguments with evidence?	86.1%	86.7%	62.5%	78.6%

¹ University of Maryland

² Bowie State University

³ Florida A&M University

The recent graduates and interns were *more likely to think*: it is very important for students to remember formulas and procedures (40% UMD; 50% BSU; 60.7% FAMU – 25.5% National). They were less likely to think, however, it is very important for students to think in sequential manner (55% UMD; 75% BSU; 53.6% FAMU – 79.6% National).

Since our new baseline data intended also to measure differences between a Predominately White College/University [PWCU] and a Historically Black College/University (HBCU), we added in the instrument a statement regarding the importance of being taught in a culturally responsive manner. Interestingly, we found that more BSU graduates (87.5%) thought it is very important to be taught in a culturally response manner than UMD graduates (61.6%). It is noteworthy that 9 UMD graduates didn't answer this question, even though they answered all other questions. On the other hand, inspection of the upper level FAMU interns responses to this question shows that only 50% reported that it is very important to be taught in a culturally response manner.

3. Teachers' familiarity with standards documents and benchmarks for science. In this section teachers were asked to rate their familiarity with standards documents and benchmarks on a scale from 1 to 5 (1 = not at all familiar...5 = familiar to great extent). Table IV summarizes the participants' responses. The percentages in this table were rounded and they reflect the percentage of teachers who choose categories 3-5 from "fairly familiar" to "familiar to great extent". The national sample group, in this section, was science and mathematics eighth grade teachers (n=478) who answered to a survey in 1995.

Table IV

Comparison between the groups' (2005 graduates, the national sample and the FAMU interns) responses to the "Teachers' familiarity with standards documents and benchmarks for science" section, by percentage responding "fairly familiar" to "familiar to great extent."

Item	National	2005 Graduates:		HBCU ³ interns
		PWCU ¹	HBCU ²	
22. What is your familiarity with the Science standards document National Science Education Standards?	NA	38.3%	25%	7%
23. What is your familiarity with the reform document Benchmarks for Science Literacy?	26%	23.3%	12.5%	11%

¹ University of Maryland ² Bowie State University ³ Florida A&M University

We found that most of the national and the 2005 graduates' teachers and interns were not familiar with the standards documents and benchmarks for science. We speculate that the difference between the two HBCU institutions regarding the familiarity with the *National Science Education Standards* (BSU-25% and FAMU-7%) may be explained by the fact the FAMU interns had not yet finished their studies. We hope to find differences in this area with our Nexus graduates.

4. *Teachers' reports of their instructional practices in science classes.* In this section teachers were asked to report on the kind of reform activities they are implementing in their classrooms. The National sample groups, in this section, were science and mathematics public elementary and secondary schools mathematics and science teachers who answered to a survey in 1996. We included only the responses of graduates who reported that they are already teaching (HBCU=7; PWCU=50), since we ask them to reflect on their instructional practices in class. First we compared the responses of the 2005 graduates to the responses of the National to document the ten years difference, and then we compared between the group of 2005 students who graduated from BSU and the group of 2005 students who graduated from UMD, to evaluate demographic differences. The percentages in Table V were rounded and they reflect the percentage of teachers who choose to answer from "Fairly" to "Great extent".

Table V

Comparison between the 2005 graduates' responses (all and divided by institution) to the "Teachers' intentions about implementing reform activities in science classes" section and the national sample responses, by percentage responding from "Fairly" to "Great extent."

Item	National	2005 Graduates	PWCU ¹	HBCU ²
24. Assisting all students to achieve high standards.	71%	87.8%	88%	85.7%
25. Providing examples of high-standard work.	48%	87.5%	88%	71.4%
26. Using performance-based assessments.	44%	82.1%	82%	71.4%
27. Using standards aligned curricula.	66%	80.3%	82%	57.1%
28. Using standards-aligned textbooks and materials.	58%	83.6%	84%	57.1%
29. Using computer-supported instruction.	17%	62.5%	64%	42.9%
30. Making connections with mathematics.	-	77.2%	78%	71.4%

¹ University of Maryland (N=50) ² Bowie State University (N=7)

We found that among all statements the 2005 graduates reported that they are more likely to use the mentioned practices, which are all recommended by the latest national reform documents (i.e., AAAS, 1993). The 2005 graduates were *more likely to*: assist all students to achieve high standards (87.8% 2005; Grad – 71% National); provide examples of high-standard work (87.5% 2005 Grad – 48% National); use performance-based assessments (82.1% 2005 Grad – 44% National); and use standards-aligned curricula (80.3% 2005 Grad – 66% National). The Largest difference between the 2005 Graduates and the national sample was seen regarding the use of computer-supported instruction (62.5% 2005 Grad – 17% National). These results probably reflect the time difference. Contemporary educators (teachers, developers, researchers, students) are much more aware of the potential of web technology than they were ten years ago (Mioduser, Nachmias, Lahav, & Oren, 2000).

Overall, along most measures the UMD graduates had higher percentages than did the BSU graduates.

Influence of Race/Ethnicity on Career Decision Making

Regarding the open-ended question, “How was your decision to be a science teacher affected by consideration of your ethnicity and/or gender? Most of the new graduates (BSU- 5 out of 8; UMD- 42 out of 60; FAMU- 19 out of 28) stated that they saw no influence of gender and race on their decision making. An example of such a response follows:

[Neither] my gender nor ethnicity influenced my decision. I always wanted to teach elementary school and I knew that science is a part of school and unlike the upper grades I knew I would teach all subjects to my students. I felt and still feel comfortable teaching (African-American female, BSU).

A few students from both Universities (BSU- 1 out of 8; UMD- 6 out of 60; FAMU – 9 out of 28) reported that they did see an influence in their choices of teaching career, or that they started to think about ethnicity and gender while learning or teaching. Several examples for such a response follow:

As an African American female I am well aware of how influential gender and race is on being successful in the field of Science. Stereotypically females and minorities are not urged to pursue science related careers and this is a real shame (African American female, BSU).

I want to be a positive Black role model for kids because I know I did not have one when I was a child (African American male, FAMU)

I was not influenced [by] ethnicity or gender when considering pursuing a career with science teaching responsibilities. However, [now that I am] working in a predominantly black school I do take into great consideration both ethnicity and gender (White female, UMD).

Growing up I was taught equality by my family. Very little in my life was motivated by race. However, I have wanted to teach for a long time. Early on I realized that being a male in a female dominated profession would be interesting (White male, UMD).

Discussion and Implications

In this report we documented our research of year 1 of Project Nexus. In year 1 the research focus was on collecting and analyzing baseline data of all the previous year’s graduates of the two institution’s (HBCU and PWCU) and compared them to a broader national sample. We believe that it is important to collect and analyze baseline data for studies in which interventions are used. By comparison of pre- and post- empirical data sets, social scientists can assert more convincingly “to citizens, business leaders,

politicians and educators “ (p. 22) that their work is credible and represents “scientific education research” (National Research Council, 2002, p. 97).

To summarize our results we will discuss: 1. the differences between the national sample and our two types of institutions, and. 2. The specific elements of our teacher preparation program that we believe would lead to teachers who are trained to adopt and convey, to their workplace, the desired practices that are recommended by newly science education reforms.

1) The differences between the national teachers and the PWCU and HBCU graduates' and interns' results

Our baseline data indicated that the two participating institutions' 2005 graduates were more likely to apply a range of practices that are recommended by national latest reform documents (e.g., *National Science Education Standards*) in their classrooms than the national sample. We believe these differences could be explained in different ways. The national group teachers were surveyed ten years prior to the current study (1995), at that time the recommendations for active learning approaches and inquiry-based learning (AAAS, 1993; NRC, 1996) just started to be recognized. Also, programs for teaching based technology were started to be developed for schools and were not integral part in the school system or in private homes like nowadays.

That overall finding was encouraging by showing some of the strengths of the existing teacher preparation programs; however, the percentages in the desired direction were higher for the graduates of the PWCU than for the HBCU graduates. We find that troubling on the local level, but inconclusive on a national level due to the sample size for the HBCU.

Of particular importance for those who seek to promote a more equitable science education, we found that more of the HBCU interns and graduates thought it was very important to be taught in a culturally responsive manner than did the PWCU graduates. Documentation of this finding is significant for those involved in teacher preparation, because the findings shed light on possible differing outcomes of teacher preparation programs that serve different populations. The results for both the HBCU and the PWCU in this important area were dissatisfying, however, since we would hope that all newly graduated teachers with science teaching responsibilities would see the value of teaching science in a culturally responsive manner. How to achieve this aim is a critical need in teacher preparation that PN will seek to address throughout its activities.

2) The specific elements of Project Nexus influenced by the baseline data.

One of the key assumptions commonly held in science education is that science educational practices require systemic reform within undergraduate science subject matter and education classes, prospective teachers' field-based experiences, and professional development during new teachers' induction years (NSF, 1998; NRC, 1996).

Marilyn Cochran-Smith and Kenneth Zeichner (2006) in their recent report “Studying Teaching Education” included under their topic “*The research we need*” made the call for a reform in teacher preparation with a focus on the subject matter and a rigorous program examination. They recommended paying attention to the demographic profile of teacher education students and entering teachers. Although there is evidence that teachers who do not share their learners’ racial, cultural, or linguistic backgrounds can be successful, we are persuaded by scholars such as Cochran-Smith and Zeichner (2006), as well as Darling-Hammond (2000) that a priority should be to recruit and prepare teacher interns of color. For that reason, we are implementing and testing our science teacher preparation continuum model at two types of universities, a Historically Black College/University [HBCU] and a Predominately White College/University [PWCU].

Our aim, which we are testing — and influenced in our implementation by the baseline data — is to improve our teachers’ preparation programs by implementation of the innovative features in the Project Nexus: recruitment into teaching of individuals with background in science, particularly those of color; connection of transformative undergraduate science content courses with reform-aligned science method courses, supported internship experiences with adolescent students in informal education contexts, field placements in urban professional development schools, and ongoing innovative educational experiences that target the needs of minority and urban students. In particular, our baseline data suggested to us the need to customize the degree of implementation of our project’s key features at the participating institutions. For example, the baseline data showed that at the PWCU more respondents were supportive of the need for explanations/arguments with evidence in their teaching than were the respondents at the HBCU. Conversely, more graduates from the HBCU were supportive of teaching in a culturally responsive manner than were the respondents at the PWCU. As a result, we have learned that it is important at the different types of institutions to regulate at differing levels of intervention (higher or lower emphasis) for particular instructional innovations based on where they begin. We see this as analogous to the differentiation movement in pedagogy for individual students, but at an institution level guided by careful attention to baseline data disaggregated by institution.

We believe these initial findings and ruminations of our Project Nexus 5-year study are intriguing as well as important to report. Our initial decision to collect baseline data has resulted in a promising idea of a way to intervene most productively in the differing types (HBCU and PWCU) of teacher preparation institutions collaborating in this innovative science teacher preparation project.

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Appendix

New Teachers Beliefs and Practices of Science

Directions: Please select the letter response that best represents your beliefs and practices.

SECTION I. Background Information

1. If you win a lottery drawing of returned surveys which prize would you prefer?
 - A. i-pod
 - B. B Kodak digital camera + Printer Dock
 - C. Either is acceptable
 - D. Neither, no thanks

2. Institution from which you graduated:
 - A. Bowie State University (BSU)
 - B. University of Maryland (UMD)

3. What grade level are you teaching?
 - A. 1, 2, or 3
 - B. 3, 4 or 5
 - C. 6 (elementary school)
 - D. 6,7,8 (middle school)
 - E. not teaching

4. Your gender:
 - A. Female
 - B. Male

5. Your age:
 - A. 20-25
 - B. 26-30
 - C. 31-35
 - D. 36 or older

6. Your ethnicity:
 - A. African-American or Black
 - B. Asian or Pacific Islander
 - C. American Indian or Native American
 - D. Caucasian or White (not of Hispanic Origin)
 - E. Hispanic or Latino
 - F. Other

Note: For the next four sections (II, III, IV, and V), please think of your vision of science and science teaching before you respond to the items.

SECTION II.

To what extent do you agree or disagree with each of the following statements?

Choices:

(A) Strongly disagree **(B) Disagree** **(C) Neutral** **(D) Agree** **(E) Strongly agree**

7. Science is primarily a formal way of representing the real world.
8. Science is primarily a practical and structured guide for addressing real situations.
9. Some students have a natural talent for science and others do not.
10. A teacher's understanding of students is essential for teaching science effectively.
11. It is important for teachers to give students prescriptive and sequential directions for science experiments.
12. Focusing on rules is a bad idea. It gives students the impression that the sciences are a set of procedures to be memorized.
13. If students get into debates in class about ideas or procedures covering the sciences, it can harm their learning.
14. A teacher's understanding of students is not essential for teaching science effectively.
15. If students get into debates in class about ideas or procedures covering the sciences, it can benefit their learning.

SECTION III.

Choices:

(A) Not at all **(B) Slightly** **(C) Fairly** **(D) Moderately** **(E) Extremely**

16. How important do you think it is for students to remember formulas and procedures?
17. How important do you think it is for students to think in sequential manner?
18. How important do you think it is for students to understand concepts?

19. How important do you think it is for students to be taught in a culturally responsive manner?
20. To do well in science at school, how important do you think it is for students to understand science use in the real world?
21. To do well in science at school, how important do you think it is for students to support their explanations/arguments with evidence?

SECTION IV.

Choices:

- | | | | | |
|-------------------|---------------------|---------------|------------------------|---------------------|
| (A) | (B) | (C) | (D) | (E) |
| Not at all | Small extent | Fairly | Moderate extent | Great extent |

22. What is your familiarity with the Science standards document National Science Education Standards?
23. What is your familiarity with the reform document Benchmarks for Science Literacy?

SECTION V. Instructional Practices

To what extent do you use the instructional strategies in science teaching that are listed below?

Choices:

- | | | | | |
|-------------------|---------------------|---------------|------------------------|---------------------|
| (A) | (B) | (C) | (D) | (E) |
| Not at all | Small extent | Fairly | Moderate extent | Great extent |

24. Assisting all students to achieve high standards.
25. Providing examples of high-standard work.
26. Using performance-based assessments.
27. Using standards aligned curricula.
28. Using standards-aligned textbooks and materials.
29. Using computer-supported instruction.
30. Making connections with mathematics.

SECTION VI. Brief Responses

31. In reflecting on what influenced you to pursue a career that involves significant science teaching responsibilities, how was your decision affected by consideration of your ethnicity and/or gender?
32. If you were at one time an undergraduate science major, what influenced you to pursue a career in teaching?