

# DIVERSITY EDUCATION FOR PRE-SERVICE SCIENCE TEACHERS

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## **Introduction**

Themes of diversity and equity are included in the science methods courses for all pre-service teachers enrolled in the Graduate School of Education at George Mason University. One of our goals in the science methods courses is to raise pre-service teachers' awareness of diversity among scientists, as well as among their own students. This knowledge is then incorporated into classroom planning and teaching. Our definition of diversity is inclusive, rather than exclusive, and includes ethnicity, gender, and special needs. While a few teacher education courses focus entirely on diversity and equity issues, the underlying belief is that diversity and equity awareness should be included in all teacher education courses.

## **Context**

### **Community and Participants**

George Mason University, located in northern Virginia and adjacent to Washington, D.C., has 25,000 students. It is a public institution that offers over 100 academic degrees at the undergraduate, master's, doctoral, and professional levels. The teacher licensure programs are five-year programs that lead to a Virginia teaching license and a master's degree. The pre-service teachers have already completed their bachelor's degree. Indicative of the highly mobile population in the area, over 75% of the pre-service teachers have earned their undergraduate degrees from other institutions.

### **Program**

In the pre-service teacher education programs at the elementary, middle, and high school levels, two science methods courses are required—a basic and an advanced course. Diversity and equity activities are taught in both courses: awareness and information-gathering activities take place during the basic course, while application to planning and teaching takes place during the advanced course. Each course is three graduate credits and includes hands-on and inquiry-based strategies for teaching biological, physical, and earth science. The courses *require* pre-service teachers to plan curriculum materials that meet state [1] and national standards [2, 3]. The

science education courses provide a unique opportunity to challenge all pre-service teachers to investigate diversity and create science lessons for all children.

### **Support**

The diversity and equity activities for the pre-service science methods courses were created with no outside support or funding. The science educator who taught the courses planned the activities and included these themes in the classes.

### **Diversity and Equity Activities**

The activities in which all pre-service teachers in science methods courses participate fall into three categories: awareness, information gathering, and adapting lessons.

#### **Awareness**

To focus the pre-service teachers on their perceptions of who scientists are and what they do, the teachers participate in two activities on the first day of the course: draw a scientist and minority scientists.

##### 1. Draw a Scientist

Each pre-service teacher is given a blank sheet of paper and asked to draw a scientist in approximately ten minutes. When all of the pictures are complete, the pictures are shared in small groups. The whole class then brainstorms to come up with a list of characteristics they think would be included in their students' drawings of scientists. This list usually includes characteristics such as, white male, lab coat, glasses, pocket protector, frizzy hair, and "nerd." When the list is complete, a poll is taken to find out which of these characteristics are in the teachers' own drawings. Most teachers find that their own drawings portray these same characteristics. The discussion for the day ends with these unanswered questions: Is this really who scientists are? Are these the impressions we want children to have? These questions are then linked to their scientist interview assignment and the promise of further discussion.

##### 2. Female and Minority Scientists

To focus on minority scientists, the students individually brainstorm to create a list of female scientists and a list of ethnically diverse scientists. Typically, the pre-service teachers, all of whom have college degrees and are in a graduate teacher licensure program, can name only one female scientist (Marie Curie) and no ethnic minority scientists. This simple activity raises their awareness of their lack of knowledge in this area. To expand the list to scientists with

disabilities, information about Stephen Hawking, one of the most brilliant living scientists, is shared with the class. Hawking continues his research in theoretical astrophysics even though he has amyotrophic lateral sclerosis, is confined to a wheelchair, and can no longer speak. These activities are then linked to the female and minority scientists research assignment.

### **Information Gathering**

In order to increase the teachers' knowledge of diversity among scientists and to expand their understanding of what scientists do, they conduct a series of short research assignments that are shared with the class.

#### 1. Female and Minority Scientists Research

Each teacher researches one female scientist and one ethnic minority scientist. Lists of names are provided, though the teachers are not confined to the scientists on the lists. Research is usually conducted using encyclopedia-type resources or the internet. The teachers return to class with one-page drawings and/or essays about the scientists they investigated. These reports are shared in small groups so that the teachers may further expand their own knowledge of female and minority scientists.

The individual pages are taped together to form two quilts. Each quilt is labeled as minority scientists or female scientists and hung on the wall. Most of the pre-service teachers choose to write reports instead of drawing a picture, chart, or diagram which leads to a discussion about the diversity in their learning styles and hence, in their teaching styles and the learning styles of their students.

#### 2. Scientist Interview

Since many people who are not scientists have misconceptions about who a scientist is and what a scientist does, the teachers in our elementary and middle school programs interview a scientist, engineer, or a person working in a technical field. The person interviewed should have at least a four-year science or engineering degree and be employed as a scientist or engineer. Someone with whom they have a personal connection, such as a spouse, parent, adult child, neighbor, or friend, is preferable. The thirty-minute interview with a scientist or engineer of their choice is summarized in a report (minimum of three pages) using a question and answer format. Teachers are encouraged to conduct the interview at the scientist's workplace. In addition to questions of their own, they ask a common series of questions so that information can be compared and analyzed in class.

### 3. Gender Equity Research

To raise gender sensitivity, videotape from *Dateline NBC* that features Myra and David Sadker and their research on gender bias is shown in class [4]. Having teachers see actual examples of unintended gender bias in the classroom has completely changed the level of discussion by pre-service teachers from denial to amazement that this really happens. At the conclusion of the videotape, the teachers break into animated discussion as they analyze the report for bias. They discuss who was called on in class and how this could be monitored for equity in their own classes. Additionally, they focus on asking follow-up probing questions as a strategy that should be used for all students, not just boys. To conclude the discussion, practices shown to reduce gender bias, such as cooperative learning, single-sex classes, or small groups, are explored.

### **Adapting Lessons**

After creating lesson plans to teach science specified by the Virginia Standards of Learning [1] to "typical" students, the lessons are adapted to meet the needs of students with special needs. The goal is to have the pre-service teachers construct a culturally and gender sensitive learning environment where children feel free to explore and learn. The learning environment should provide opportunities for children to learn diversity-related science content, as well as to learn about role models. The topic of role models does not have to be forced; many opportunities for learning about diversity occur naturally within the subject matter. Also, attention should be paid to the individual learning styles of each child.

#### 1. Planning Lessons

The pre-service teachers randomly draw four student case studies, one from each of four categories—English as a second language, learning disabled, physically handicapped, and gifted and talented. They then conduct research to learn more about meeting the needs of their case-study students. The pre-service teachers learn about their students, plan lessons so that the content makes use of examples with which students can identify, and plan units that are taught in ways that take advantage of the students' strengths as learners. Their previously planned lessons are adapted to their four special needs children, emphasizing abilities rather than disabilities.

#### 2. Teaching Lessons

In pairs, the pre-service educators teach a standards-based lesson, while at the same time addressing the needs of diverse learners, to their fellow classmates. When teaching the lesson, they first give an overview of where the lesson fits into the unit, and then teach the lesson as they

would to children. Lastly, they share the strategies they have demonstrated and show how these meet the diverse needs of learners. The entire lesson is videotaped.

### 3. Videotape Analysis

The pre-service teachers analyze the videotape of themselves teaching model lessons to students with different needs. They identify effective teaching and areas of growth.

### **Evaluation Process**

The pre-assessment and summative projects show that pre-service teachers can make great gains in knowledge about teaching and learning for female and minority students and that they are able to demonstrate these new skills. Since these projects are part of a graduate program, pre-service teachers are graded on the quality of their projects. This lets us know how we are doing each semester.

As part of the on-going improvement process, all of the pre-service teachers evaluate each assignment, as well as the course, and make suggestions for improvement. Since these assignments have been used for at least five years, there are few suggestions for improvement and they remain highly rated as valuable learning experiences.

### **Outcomes**

#### **Awareness Activities**

Pre-assessment shows that most pre-service teachers are not able to identify female and minority scientists, nor do they know how to adapt lessons for female and minority students. By the end of the science methods courses, all pre-service teachers are able to discuss a variety of scientists, as well as demonstrate how to adapt lessons to meet the diverse needs of learners. The "draw a scientist" activity helps the teachers understand their own conceptions of who scientists are and what they do.

#### **Information Gathering Activities - *Scientists Are Real People!***

Learning about specific scientists helps to make science personal and, therefore, real. After learning about a particular scientist, a surprised child exclaimed, "Scientists are real people!" We thus had a name for our information gathering activities.

One unanticipated outcome of the interview assignment was the need to actually define “scientist” in broad and varied ways. As scientists, most of us naively assume that people know who we are and what we do. In class, the teachers share their interviews in small groups. Many are surprised to learn that scientists like what they are doing, that many of them became interested in science late in their elementary career or in middle school, and that they recommend hands-on experimenting as the way to teach science. Most assignments are not life-changing, but each semester a few teachers report significant personal events related to the interviewing assignment. One that remains most vivid for me is a young woman who was in tears as she explained her interview. This young woman was pregnant, had been married for approximately six years, and couldn't believe that she had not known what her husband did. She summed up her feeling when she asked, “What have we talked about for the last six years?” Later in the semester she became excited and started shouting, “That's it, that's it, that's what he does” as she pointed to the screen on which played a short videotape on remote sensing research.

Gender discrimination in teaching is a behavior that pre-service teachers either denied they did, or would do, until we found a videotape of teaching on which to base the discussion. Actually watching effective teachers unknowingly discriminate against female students raises the level of awareness on the complexity of teaching to all students. It also provokes discussion on things to watch for and strategies for analyzing their own teaching.

Learning about their own preconceptions and gathering information about scientists are ways teachers can learn about scientists and increase their knowledge about a diverse group of people.

### **Adapting Lessons Activities**

By adapting lessons for specific students, teaching lessons, and critiquing lessons taught, the pre-service teachers expand their repertoire of teaching strategies and student needs. After these activities, they are better prepared to investigate how to teach science to children who have diverse needs, abilities, and backgrounds. The strength of the program is not based on a single activity: it is found in the series of activities that together provide an *emphasis on meeting diverse needs*.

### **Opportunities for Further Action**

The awareness and information gathering activities are working as well as they are because they enable the pre-service teachers to plan for teaching, to articulate what they have

done, and to understand how this knowledge can actually help students learn. However, the immediate application of this information to a real teaching situation with children, instead of their peers, would enhance the learning experience. Teachers would then be analyzing videotapes of their own classroom teaching. A solution might be to have pre-service teachers work with special needs children in a tutoring situation or assist a teacher with the special needs of a child in class before they begin their own student teaching assignment. ■

## References

- [1] *Standards of Learning for Virginia Public Schools*. Board of Education, Commonwealth of Virginia. Richmond, VA, 1995.
- [2] *National Science Education Standards*. National Academy Press, Washington, DC, 1996.
- [3] *Benchmarks for Science Literacy*. American Association for the Advancement of Science: Project 2061, Oxford University Press, New York, 1993.
- [4] "Early Learning Effects on Female Students: Gender Bias in the Classroom," *Dateline NBC*, Hosts Jane Pauley and Stone Phillips, NBC Network, 1993.

**INTERVIEW WITH DONNA STERLING**

**Q: What career path did you follow to reach your present position? Is this what you originally aimed for, or were there twists that brought you here?**

**A:** I was a research scientist, but married someone who traveled throughout the world. As a result, I began teaching early in my career. My travels made for a high level of multicultural awareness from a personal perspective. In the various countries in which we lived, such as Thailand, I was a cultural minority as well as a minority in terms of being a female scientist. I understood the situation and loved the challenge since I thrive on change. These experiences fueled my interest in issues on diversity.

**Q: Have you been involved in similar programs before? Was there a particular moment or stimulus that caused you to begin this project?**

**A:** Because of my experiences in other countries, my observations of prejudice, and my sincere interest in cultural understanding, I wanted to create a program for science teachers to further their understanding of cultural diversity and gender equity among scientists. In addition, as a teacher, I often meet students who are from other countries. In many cases, I have lived or traveled in their country. This gives us a natural connection. Helping teachers to connect with their students and their students to connect with the science being taught are all part of good teaching.

**Q: Have there been any unique or unexpected consequences for you resulting from your project?**

**A:** I was surprised to find that many college graduates did not know what were typical science careers. This came to light when K-8 pre-service teachers had to have a discussion about who were scientists before they could complete an assignment to interview a scientist. In addition, I am flabbergasted at the stereotypes people have about scientists at times. These often come out when I have students draw a scientist or in classroom discussions.

**Q: Are you able to identify the greatest lesson you have learned and the rewards you have gained through working on your program “Diversity Education for Pre-Service Science Teachers?” What is the greatest benefit you see coming to students—and teachers—through their engagement with this project?**



**A:** I've learned that change takes a long time. I am still surprised by how long it takes sometimes. I believe awareness of equity issues is the first step in attaining diversity and gender equity. In many cases it is not easy to raise people's level of awareness. For example, in my classes conversations on gender equity were filled with denial before we began using a videotape of a teacher unknowingly discriminating against girls. People initially refused to believe that they would discriminate, until they saw a good teacher doing some of the things we spoke of in class. They could actually see it on tape. Through viewing videotapes and classroom discussion, a large amount of self-awareness was gained, along with a realization of student-to-student and teacher-to-student relationship dynamics. My greatest reward is visiting with teachers and talking about all the things they're doing now with students as a result of taking the pre-service science methods course.