Chairman Mollohan, Ranking Member Wolf, and distinguished members of the Subcommittee, my name is Julie A. Luft and I am honored to be here today to discuss inquiry based science teacher education. I have been involved in science education for 5 years as a middle and high school classroom teacher and 15 years as an academic in institutions of higher education. My teaching and research responsibilities over the years have focused on secondary science teacher education. At the national level I am the Director of Research for the National Science Teachers Association, an Associate Editor for the *Journal of Research in Science Teaching*, and an incoming American Association for the Advancement of Science Fellow.

I want to thank you for inviting me to speak to you on the important topic of science education. My passion for this topic was certainly the result of science teachers who heard my questions and encouraged me to find the answers. The investigations I engaged in were not always planned, nor were they in the textbooks. But they did provide me with an opportunity to conduct experiments, collect and analyze data, and make conclusions. These early experiences were captivating in that they allowed me to explore what I did not know, develop solutions to problems, and better understand our natural and made-made world. As a teacher, I tried to provide these same opportunities to my students.

The *National Science Education Standards* [NSES] (National Research Council [NRC], 1994) is explicit in its statement that science as inquiry is a content standard for K-12 students. This means that students need to develop the abilities to do and the understandings about science as inquiry. This includes. “making observations; posing questions; examining books and other sources of information; planning investigations; reviewing what is already known in light of evidence; using tools to gather, analyse and interpret data; proposing answers, explanations and predictions; and communicating the results (p. 23; NRC 1996).” Ultimately, a science as inquiry instructional approach cultivates the abilities of students to think scientifically, which will help students better negotiate the different disciplines of science and help build their capacity to be scientifically literate citizens.

Science as inquiry is typically approached in two ways: a way to teach, or a way for students to learn. For science teacher educators, we have to consider both when working with future teachers. We have to provide those in teacher education programs with experiences in which they can learn about inquiry, so that they can create inquiry environments that provide an
opportunity for their students learn important science concepts. While this sounds simple, it is not.

In order to learn to teach using inquiry, teachers need ample opportunities to practice using inquiry instruction, knowledge in the content area they are teaching, knowledge about the nature of science, knowledge of student learning during inquiry, and access to inquiry based curriculum. Developing science teacher education programs that addresses each of these areas is possible, but it requires collaboration between education and science faculty, and teachers and administrators in local schools. In this collaborative effort, there also has to be time dedicated to develop and assess common goals and outcomes related to inquiry.

As a science teacher educator, I constantly contemplate how to cultivate an understanding of inquiry among our future and current science teachers. In developing courses and programs, I have to consider the challenges previously mentioned. To understand if my innovations, instruction, or programs are assisting teachers in developing their abilities around inquiry, I conduct studies and look at the findings of my colleagues.

Recently, I have been involved in research that examines how beginning science teachers enact inquiry in their classrooms. These are teachers who have graduated from teacher preparation programs, and who may or may not stay in teaching. Beginning science teachers are important to study as they know about inquiry, want to use inquiry in their classrooms, and they will become experienced educators who use inquiry.

This research project has been funded by the National Science Foundation since 2004. In this study, my colleague and I (Dr. Roehrig, University of Minnesota) were interested to see if we could support beginning science teachers to use more inquiry than has historically been observed in their classrooms. To do this, we designed a study that following beginning science teachers during their first through third years in the classroom. While these teachers were in the classroom, they engaged in different forms of professional development for new teachers. These programs are called induction programs. Half of the teachers participated in induction programs that focused on teaching science and using inquiry, while the other half participated in induction programs that focused just on teaching. In observing these teachers (over 100) every other month and interviewing the teachers every month for three years, we found that:

Teachers in science induction programs enacted more inquiry than did their peers in other programs - The new teachers who had access to ongoing support to teach science as inquiry did create more inquiry environments. This support provided the new science teachers with instructional materials, assistance to create lessons, feedback on one’s teaching, and countless opportunities to talk about teaching science.

Science teachers learn about student learning as they work with students – As our teachers worked with students, they began to understand how students learned during inquiry instruction. This provided the new teachers with opportunities to understand how different instructional formats impacted student learning.
These findings are important for two reasons. First, they suggest that new science teachers need comprehensive support as they continue to learn to teach science. Most induction programs to support new science teachers focus on teaching, and not on teaching science. Second, faculty who prepare science teachers need to continue working with their teachers as they start their teaching career. Most new teachers are supported by school district staff, who may or may not know about teaching science. By focusing on teaching science and involving teacher preparation faculty in induction programs, new science teachers will be supported to develop an inquiry practice in their first years of teaching. The abilities and knowledge developed during these first years will continue throughout their careers.

While this research tells us about the inquiry instruction of beginning science teachers, it can also reveal what type of experiences in teacher preparation can support the use of inquiry among new science teachers. In an analysis of our current data, we were able to determine what aspects of teacher preparation supported the use of inquiry in the classroom. Our qualities are consistent with the literature in the area of science teacher education (e.g., Abell & Lederman, 2007; Cochran-Smith, & Zeichner, 2005; Richardson, 2001). Some of these areas are:

**Experiences in classrooms** – The value of working in classrooms to learn how to teach inquiry and how students learn through inquiry is essential. Teachers who learn to teach science during their teacher education program will have the tools to do so in their first year. In our research and the research of others, the more opportunities the teachers have for high quality classroom experiences, the more likely they are to implement inquiry in their classes.

**Courses that focus on learning to teach science** – Science teachers are unique. They must take what is known in science and translate it into something that students can understand. In our study, beginning science teachers enacted more inquiry if they had opportunities to reflect on the process of science and their own science instruction. These courses explicitly have teachers learn how to teach the content in manner that supports student learning.

**Degrees and certification are linked together** – Science teachers who received their certification to be a science teacher as part of their undergraduate or graduate degree did have a sustained use of inquiry. Embedding the certification process in the learning of a content area is important in fostering the use of inquiry among teachers.

In doing this research and in working with science teachers, I have learned that there are additional areas that impact the use of inquiry in the science classroom. These include:

**According to teachers, current forms of standardized testing are impacting science instruction** – In NSTA’s survey of science teachers, science teachers reported that standardized assessments impacted their teaching of science. One of the unintended consequences of these assessments was the loss of time spent on inquiry in order to achieve the articulated state standards. While assessment of student learning is important, it needs to occur in a way that can provide students with an opportunity to engage in inquiry and in a way that can continue the professional development of science teachers. I am hopeful that new legislation will take this into account.
Supporting a science as inquiry approach requires education and science faculty to work together—Science and education faculty each have important responsibilities as potential teachers participate in science teacher preparation programs. Science faculty need to use methods of teaching that promotes deep understanding of the content and the processes of science. Education faculty need to help new teachers learn how to translate this knowledge into student learning. Teacher preparation programs that are coordinated by both groups of faculty are in a better position to help science teachers understand, enact, and evaluate their use of inquiry in the classroom.

As a science teacher educator and researcher, I have pleasure of working with teachers, other science teacher educators, and others involved in the science education endeavor. In working with these individuals, we have developed ideas to explore, test, and share ways to learn and teach science (which includes science as inquiry). During the process of exploring and testing, I am in contact with the different federal agencies. I have worked primarily with the National Science Foundation, but I have also been involved in projects supported by the Department of Education. In my work with these agencies, I have learned a great deal. I am appreciative that they exist and that they support my work and the notable work of others. I would also like to suggest areas in which I think federal agencies could expand in order to better meet the needs of science teachers. These include:

More support for research in the area of science education—More research is needed in science education. By understanding how students learn science and how teachers can better teach science, our students will be prepared for the challenges of the 21st century. Research that is needed must be in the different science disciplines, between the different disciplines, and in the informal and formal learning environment. Inquiry is an important part of learning about science (Duschl, Schweingruber, & Shouse, 2007; NRC, 1996), and it needs to be addressed in science education.

An emphasis on translating research into practice—Placing research in the hands of teachers is critical if we are going to change how science teachers teach. While projects that provide opportunities for teachers to engage in science are noteworthy, more needs to be done to provide teachers with research experiences in science education and in disseminating the findings of science education researchers. By appropriately disseminating research to teachers, teachers can explore and learn practices that will improve the learning of their students.

Long term support for science education research—If science teacher education researchers are going to understand the impact of science as inquiry (teaching and learning); then it is important to consider the support of long-term research projects. In the science and medical fields, researchers know that that they can engage in a long period of study regarding a problem or in looking at the impact of an invention. In science education, our studies are often confined to short periods of time (a few years) and require that we modify our research direction. Long terms studies and projects, that also have an emphasis on translating research into practice, have great potential to increase what we know in science education and to impact science instruction in the classroom.
Consistent funding for federal agencies involved in science education – The National Science Foundation has played an important part in advancing our knowledge in the areas of science education. In order for this organization to continue their important work, increased support for research and dissemination is needed. Every effort has to be made to at least maintain, but really increase the funding provided to the National Science Foundation for research, development, and dissemination in science education.

Mr. Chairman and members of the committee, science educators are very encouraged by the Administration’s strong commitment to science education. For instance, we are encouraged by the coordination of the different science initiatives through a central organizing group. This initiative is groundbreaking and will ensure that there is a coordinated effort to improve science education from schools to institutions of higher education. Ultimately, the well-being of our country resides in the science education our students encounter today. The education our students receive today and tomorrow will be a result of coordinated and adequate support for work in science education.

I thank you for this chance to testify here today and look forward to answering any questions you may have.

References