The 2017 AERA theme is Knowledge to Action: Achieving the Promise of Equal Educational Opportunity. How does your scholarship align with the 2017 AERA meeting theme?

A goal for me in curriculum development was to strive for equal educational opportunities for students. Two examples provide evidence. As co-director of the Systemic Initiative for Montana Mathematics and Science (SIMMS) Project, many people, nationwide, helped with setting foundations of a meaningful, relevant, and integrated mathematics curriculum using the latest technological tools. The purpose of that project was to change the high school curriculum of mathematics and science education in Montana. Our primary goal was to provide a complete 9-12 integrated mathematics curriculum that included topics such as game theory and chaos theory that are not traditionally included in high school mathematics curricula. That project had teachers trained in writing for the grades 9-12 audience. There were approximately 75 teacher writers and 8 university personnel who worked on the curriculum. The teachers were primarily from Montana but included others from across the United States. All had submitted writing samples before they were selected. They learned to use the latest technology available then, worked with Native American tribal elders and consultants from the Montana Department of Education to learn nuances of learning for natives, learned applications of mathematics found in daily life or from a historical perspective from native leaders, and took special training to avoid bias in language that pertains to issues such as sexism, disabilities, and race and ethnicity. This took place in light of the fact that in the 1990s, when SIMMS was being developed, project directors in consultation with curriculum specialists at the Montana Office of Public Instruction decided that all writers needed the training to avoid using common language used in many books that could be deemed by some to be prejudiced or biased against some minority groups who might be using the materials.

Pre- and post-writing work included studying learning theories in mathematics, the art of questioning and professional development for teachers. Because learning theories influence how a curriculum will be written and how it
might be taught, it was important for writers to be aware of and cognizant of how theories affect the curriculum. For example, instead of simply stating a theorem and giving a proof as is sometimes done, it was important for writers to know and understand that students using the material needed some context or reason for the theorem. That context or reason might be the result of the mathematization of a problem context, or the theorem might be built from a constructivist view by considering a pattern from many cases. This curriculum was researched with students and teachers in different environments from single math-teacher schools to large inner-city schools in El Paso and Cincinnati, from reservation schools to schools that had heterogeneous student populations. Texts and associated materials were published by Kendall Hunt Publishing Company and rights have reverted to the Montana Council of Teachers of Mathematics. The expected impact was to change the teaching of all grades 9-12 in Montana with an expectation of spread to other parts of the United States.

Another project I co-orchestrated, The Figure-This! campaign for the National Council of Teachers of Mathematics, was developed with the Council, the National Council for Minorities in Engineering, and the Widmeyer Communications Group. Recognizing the complex issues of family life and the need for higher-level thinking by all students, Figure-This! created challenging problems to be used in homes by families of middle-school-aged children. These problems were examined through the eyes of caregivers for readability and sense making for those who did not necessarily have background in school mathematics. Extensions included publishing the works in Spanish and free print to all at figurethis.nctm.org. At the time the materials were produced, Spanish was the primary language of minority students in the United States and because the material was produced under a federal grant from the National Science Foundation and the US Department of Education, the producing organizations wanted it to be truly available to all without cost. The materials are publicly available at www.figurethis.org.

You are known for your work, inter alia, as the President of the National Council of Teachers of Mathematics (NCTM), what do you see to be some important contributions of this work to the field of educational change?

As time progressed and families became more mobile, and less fixed than in earlier eras, the need for more standardization in mathematics became an important issue. Prior to 1989, it was assumed that students at a particular grade level across the United States were studying the same mathematical topics. Also with time, the introduction of technology including the use of calculators, computers and later technologies and software brought about a need to re-think the curriculum and how it was taught. The Curriculum and Evaluation Standards for School Mathematics (NCTM 1989) was started to make states and school systems think about how and what was being taught and to begin the effort to add coherence to curriculum across the country. In turn, this document provided the biggest single influence on standards in mathematics education in the United States and possibly in the world. Books and articles have been written about this influence which was likely far greater than was envisioned by the writers. As a result of the mathematics standards for example in the United States, other disciplines soon developed standards, and essentially all sets of standards have grown out of that movement.

Lesser known but highly influential in the later movement toward common core standards was a study by Lott and Nishimura published as Standards and Curriculum: A View from the Nation A Joint Report by the National Council of Teachers of Mathematics (NCTM) and the Association of State Supervisors of Mathematics (ASSM) (NCTM 2005).
One reason for this study was the continued concern over standards and achievement as evidenced by the Third International Mathematics and Science Study (TIMSS) and continuous criticisms that the mathematics curriculum in the United States was “a mile wide and an inch deep.”

The study led by Lott and Nishimura was specifically designed to provide a better understanding of this perception by determining similarities and differences in state standards that direct curriculum. The study assembled a panel of 74 national leaders, including 47 state supervisors of mathematics/representatives, 12 mathematicians/statisticians, and 15 mathematics educators who compared state mathematics standards in 2004. The methodology used was based on the Second International Mathematics Study (SIMS; Bulletin IV, IEA, 1979). For the comparison, a template was constructed at grade level including all topics that could be found at a specific grade level and given to teams of participants who used the template to examine state standards. A coding model used ‘0’ for no agreement and ‘1’ for agreement on a standard at the grade level. Minimal training was required for the use of the coding device; a simple check on the reliability of the system was based on 16 sample standards used by individual groups in coding.

Several problems were encountered: not all states had standards; some states did not have grade level standards; participants found that they frequently had to interpret what a standard said. As a result, a recommendation was made to indicate agreement on a standard if at least 25 states examined had that standard expected to be met. There was more agreement for lower grades but much less at the grade 9-12 level. For the grades 9-12, or the secondary school mathematics curriculum, students in different states had many options based on what was locally required for high school graduation. Some states required two years of mathematics while others required many more. The allocation of these years to mathematics topics varied as well. Some required two years of general mathematics; others required algebra and geometry, or other mathematics topics.

Whether or not one likes the current Common Core State Standards for Mathematics (see http://www.corestandards.org/Math/), the movement for standardization in mathematics has produced the first semblance of a coherent plan for mathematics curriculum in the United States.

Given your focus on education in general and on mathematics education in particular, what would be some major lessons we can learn from local and global educational changes?

Change is coming in mathematics education because technology has “leveled the playing field” for the discipline. No longer does one country stand alone in a discipline. Differing approaches to teaching, different curricular topics, and differing technologies appear to be rare as teachers and curriculum developers share content and ideas through the Internet. An example is the mathematics education research group on Facebook. Teachers from around the world constantly seek advice on topics and teaching approaches, on a daily basis. Technology has become more commonplace through the use of cell phones even in poorer countries giving students access that was not available in earlier years. As a result, teachers and curriculum developers have to consider the use of technology as a mathematical tool. Such technology use was frequently not possible when technology was so expensive until not very long ago. But now in many cases, less affluent countries use technology because no landlines are necessary to make it available. A conversation should now occur to determine how this technology is changing our discipline.
One example of where such conversation is beginning to occur is in the Park City Mathematics Institute (PCMI) International Seminar. This seminar brings mathematics educators and secondary-school teachers together from up to eight countries for a week in selected summers for a week to identify international problems. Some of the issues discussed cover questions of curriculum while others have dealt with teaching conditions and tools to be used. At the end of these gatherings, briefs are written to discuss the identified issues and possible solutions. These briefs are available at pcmi.ias.edu.

An example brief written on complex numbers (a combination of a real and an imaginary number in the form a+bi) revealed that some countries no longer teach those numbers in secondary schools, some teach a minimal amount of arithmetic with these numbers and examine them only as needed to solve quadratic polynomial equations, and yet others use them to study transformational geometry. The document revealed that the scope of teaching about these numbers is so different around the world and that this difference is significant and has implications for curriculum in colleges and universities, which typically assume that these numbers have been introduced and developed in secondary schools. That some countries no longer treat them at the secondary level has implications for students who may choose to study abroad.

Another brief focuses on conditions of teaching in Chile where, participants followed a Chilean mathematics teacher (via film) having to work multiple jobs during a single day to make a living. Many lessons regarding educational change can be learned from that brief including the need for a living wage for the profession and support within a school system for teachers.

Other relevant changes pertain to issues of tracking, or gifted education, which is a primary concern as are the use of testing and the dropout rate in mathematics of U. S. students. These issues do not go away; they affect schools, teachers, and students in many ways as much as affluence and wealth does. Not only do these issues confront the system, but also the perspectives of teachers, parents, and the public at large stand in stark contrast to insights gleaned through research. It is clear that ways to educate the public on the use of research to make change are needed.

Young people (students) are the focus of educational change for improvement. From your perspective, what are the key needs of young people at this time and what might the field of educational change prioritize in order to meet these needs?

A key priority is for us to learn about students’ use of technology from IPhones to gaming systems. We as researchers need to rapidly learn ways to harness available technology for learning. It might already be too late. Children in countries around the world have access to technology in a much larger way than do children in some parts of the United States. Few books and articles talk about this technology because it evolves so rapidly. Students’ access to information is almost inconceivable. When six-year olds can link games and phones together for play in minutes, schools with no, or little, technology are irrelevant in today’s world.

Traditional comparative research is becoming irrelevant and outdated. A 1980s-type dissertation on the use of writing with computers where some students were not allowed to use computers while others did for purposes of the study is no longer relevant in today’s world where any student can, and typically, does communicate with hundreds of others every day around the world through social media. This contrast makes a review of current research methodologies a necessity. The world will not wait on research on the use of technology in schools. Change in educational
What do you think are the most important issues in educational change today? What excites you about the educational change field today?

The exciting thing about educational change is its catching up with and adapting to today’s technological world. This issue is not curriculum specific but more urgent than most curricular-specific issues. For example, in the area of research and publishing, it can be a matter of years from the inception of a study until the publication of results. Shortening this time span (to reduce graduate student debt) has resulted in many quick studies with few participants causing them to be of very limited value for widespread use. With the smaller studies, there needs to be more meta-analyses to try and combine studies to see if more generalizable conclusions can be found. Such an approach might help if many little case studies can be examined to see if there are wider patterns. Without those larger studies, generalizability is virtually lost in today’s research climate. Technological tools can facilitate such meta-analyses.

But until this happens, educated communities can ensure healthy educational practices. I recently read about the issue of flossing in the dental world and the lack of supporting research to justify it, but the outcry of dentistry about its value has been primary in calling for its continued use. The gold standard for research in the medical community on this issue is not met, but the community has reacted to ensure its practice. It is time that the educational research community, like dentists, ensure the practice of what we already know, make informed decisions about when and where research is truly needed, and advocate for best practices if gold-standard research is not available.