To honor Marjorie Chapman, a teacher, and her husband, an engineer in management, the “Improving Physics and Chemistry Teachers Scholarships” Endowment Fund was created at Arizona State University by Jane and Paul Jackson, to support teachers who participate in the Modeling Instruction Program. To donate: http://asufoundation.org/endowmodeling or 480-965-6468.

APS President and Jane Jackson: 2014 APS Excellence in Physics Education Award to High School Modeling Instruction

Jane Jackson: guest of honor at ASU Department of Physics Awards & Recognition Ceremony (April 26, 2016)

Physics is everywhere:
The profound influence of physics in my life and career.
(guest of honor speech, April 2016)

I celebrate the 50th anniversary of earning a Masters degree in physics at ASU. And Linda Raish asked me to say, I am the first woman who earned a Ph.D. in physics at ASU. [The audience applauded.] That was in 1970.

What is most important? I ask myself that, often. What is most important to me is growing in wisdom and love; i.e., evolving in character. Love encompasses and includes understanding – so understanding is important to me. Physics is a great way to understand the world. Physics has profoundly influenced my life & career.

When I was a teenager, I wondered: “What is the essence of reality? What is life? What is the essence of being a human? I finally said, “These questions are too hard; I cannot address them!” Then I asked, “What is the essence of physical reality?” I decided, “This is do-able. I can pursue this question.”
In high school, I took physics. It was boring, textbook-oriented, seemingly unrelated to my questions and my life. At the public library, I checked out THE EVOLUTION OF PHYSICS by Albert Einstein & Leopold Infeld. It convinced me to become a physicist. It seemed to address the essence of physical reality.

My career is in physics education. I taught physics for 18 years: 8 at South Dakota State University, and then 10 at Scottsdale Community College. Since then I have worked for 22 years in the ASU Department of Physics, co-directing the Modeling Instruction Program, which is professional development for high school teachers. Modeling Instruction produces thinkers; it promotes understanding in science.

My greatest accomplishment was expanding Modeling Instruction to the nation. In 14 years at ASU, I grew the program to 50 Modeling Workshops nationwide each summer. 10% of the nation’s physics teachers have taken a Modeling Workshop.

In my daily life, physics has a profound influence, too! Every day, I am aware of physics. Physics is everywhere! I use physics, not just for fixing things around the house, but also when I move my body. When I sit, stand, lie down, I am aware of being in a gravitational field. My massage therapist, Valerie Corbin, contributes to our scholarship fund each year. She took engineering at Ohio State, and she laughingly says, “our bodies are anti-gravity machines in an unstable 3-dimensional environment.”

If I hadn’t studied physics, I wouldn’t be so aware; I wouldn’t make these connections. Education empowers us to understand. Understanding enhances our awareness. Awareness magnifies our appreciation, our awe and respect for nature.

Global warming: how often do you think of it? I think of it daily. I look at the sky, and because I know physics, I can see in my mind’s eye the invisible blanket of CO2 that is growing, day by day, when we drive our cars, and when we burn the world’s coal, oil, and gas. Global warming is by far the biggest challenge to humanity. We could destroy civilization. What is at the heart of understanding global warming? Physics.

That is why I persist in Modeling Instruction in physics – it empowers people to become aware, make connections, see cause and effect, THINK. And appreciate nature and our place in it – and, I hope, to work to slow down global warming.
Backtrack: I grew up in the country, in Connecticut. My world was school, 4-H, church activities, and nature. I had a stable home life; my father was an engineer in management; my mother was a teacher -- who, as a child in Massachusetts, was abandoned and unloved. She always wanted to be a teacher. Encouraged by her social worker, she worked her way thru teachers college during the Depression, and taught English and history. My parents expected a lot of their 3 daughters. “You finish what you start!“, they said. “You joined 4-H, so you sew a dress and you enter it in the dress revue!” My father put us on piecework, rather than an allowance. If we wanted more money to buy comic books, we had to choose bigger-paying tasks! These lessons in taking responsibility, and connecting cause and effect, have stayed with me, in physics and all of life.

I was given two sayings in my childhood, that have guided me all my life:
* “Judge not, that you be not judged” along with “Judge righteous judgement”.
* (a female teacher):“Kindness is a woman’s glory, her scepter and her crown.”

I met my husband, Paul, on my first co-op job in New York City, age 18. I was a sophomore at Antioch College in Ohio. He had graduated from ASU, and gone to New York to get into broadcast journalism. On our 2nd date we decided to live together for the rest of our lives. This is our 54th year together. KINDNESS is a key to our marital success [audience applauded], along with humor and tolerance.

Since ASU tuition was low, Paul brought me here in January 1963. He worked full-time at KTVK, which was ABC, channel 3, and he put me through school.

General physics at ASU was terrible – lecture, cookbook labs. I almost switched to math. But advanced lab was great! My lab partner and I didn’t understand capacitors, so we chose to make one, and take measurements on it. Having freedom to choose a project, in order to understand, made it memorable.

I did well in physics, so the faculty asked me to stay on as a graduate student, with a National Defense Education Fellowship. Prof. Arnold Meister gave me office space in the basement of the B-wing, in his storage room. Faculty were kind and encouraging, especially Dick Jacob and Arnold Meister. I was always the only female in the class, but I never thought about it. My studies and my husband were most important to me.

ASU graduate school were the most fulfilling years of my life! I took almost every physics course, and loved every bit of it. My favorite professors were Dick Jacob for quantum theory, and David Hestenes for statistical mechanics and relativity –
he taught us geometric algebra. I love how geometric algebra unifies Maxwell’s equations. Dick Jacob’s quantum physics homework was daunting; I would think “I cannot do this”, and then I would plow through and DO it. I did so well that he hired me to grade homework for that course.

I aced all graduate courses but one. It was not the lectures that made for success. I have learned very little in lectures. It was the DOING: homework, writing out the logic on my own, outside of class.

In summers 1966 & 1967, Paul and I drove to Washington DC, where I worked at Naval Research Labs in solid state physics. On the drive home that second summer, I studied for the comprehensive exam. It was satisfying to synthesize my learning on 4x6 index cards – and that fall, I got the highest grade ever attained on the comps, Dr. Meister told me. That bolstered my confidence.

My dissertation was in theoretical high energy physics. I published 3 papers, and gave a physics colloquium. Dick Jacob arranged for me to teach the two mathematical physics courses. I enjoyed that -- more so than research.

[I could not say this – I choke up; I am so grateful!] I almost died in childbirth in May 1969. I lost all my blood and my veins collapsed. My hospital bill was huge, and I had no insurance. The physics graduate students and faculty did one of the kindest things I can imagine; they gave blood. Their 12 pints helped pay the bill. And the physics department gave me a summer job, grading homework for Dick Jacob. I brought the baby; she was the department mascot.

All these years, my husband worked full-time at KTVK - Channel 3, and studied part-time at ASU for a PhD in English. We both received doctorates in May 1970.

There were no jobs for women in physics, so we decided that Paul would seek a job. He got a faculty position at South Dakota State University. I volunteered in the physics department for 6 years, then taught calculus-based physics for 8 years.

Sometimes knowing physics can get you into trouble. I volunteered for the nuclear freeze movement. Since I knew physics, the group said that I should be the one to write letters to the editor. I did, and as a result our house and car got spray-painted with hammers and sickles several times in a year.

After 14 years at So. Dakota State University, my husband was totally fed up with the devaluing of education in South Dakota. “Jane”, he said, “Let’s go back home
to Arizona. We’ll both look for a job.” I got one: at Scottsdale Community College. I taught physics and built the astronomy program, adapting ASU labs provided by Anne Cowley. I made classes active learning and relevant; it was hard but fun.

In 1991 I learned about ASU Modeling Instruction. I saw that it was interactive engagement. It was much better than anything I could have thought of. I tried to implement it, but failed. To succeed, most teachers need a 3-week Modeling Workshop.

In 1994 David Hestenes called me. “Jane”, he said, “I need your help, desperately. I’ve just been awarded $4 million by the NSF, for Modeling Instruction, and my intended project director can’t get released from his job. It will only be part-time; you can still work at SCC”. It soon turned into a fulltime job – for 20 years.

Most important, for my work at ASU, are to share my delight in understanding the world, and my deep concern for the well-being of young people and future generations on this fast-warming planet. We need a nation of thinkers. Modeling Instruction promotes thinking.

Background: David Hestenes developed Modeling Instruction in ASU calculus-based physics, in the 1980s. Malcolm Wells, physics teacher at Marcos De Niza High School in Tempe, adapted it for high school. ASU is internationally known for it. Singapore, tops in the world in high school science test scores, has sent 43 physics and chemistry teachers to ASU, to take our 3-week Modeling Workshops, in nine years [audience applauded]. And each year Singapore flies two of our peer leaders to Singapore, to lead Workshops there. That’s strong evidence of success!

For Arizona, ASU’s Department of Physics has done a great service, by alleviating a chronic shortage of qualified physics teachers. We provide research-validated professional development for 50 Arizona teachers, each summer. Many local schools use it. Ours is the only such program for physics and chemistry in Arizona – in fact, unfortunately it is one of very few in the entire nation! We have served 1000 Arizona teachers! Modeling Instruction is the foundation of our MNS degree with concentration in physics, which Prof. Bob Culbertson directs. 70 teachers have earned this degree since 2003.

Modeling Instruction re-creates scientists’ practice, in the classroom. The central activity of scientists is building and deploying scientific models. That’s what we do. Modeling Instruction reveals the structure of physics. And it promotes
teamwork, communication, and problem-solving skills. It develops character: empathy, self-reliance, grit. That’s our work -- social and cultural embeddedness in the community, an ASU Design Principle.

Until 2011, we had Federal grants administered by the AZ Board of Regents, and free tuition. **In 5 years we helped 70 out-of-field Arizona teachers to become Highly Qualified (NCLB) in physics, chemistry, or general science.** We can no longer get these grants, so we must become self-sustaining. Without free tuition, ASU courses are unaffordable for most teachers. We now serve HALF as many teachers, on 1/5 our previous budget ($50,000 per year, instead of $250,000).

**Due in part to this insufficient funding, the shortage of local physics teachers is worsening -- fast! 1/3 of the 100 local district high schools face an imminent loss of physics.**

Arizona’s neglect of physics in recent years threatens the state’s future, because high school physics is the chief STEM pathway. You’ve heard the saying, "For want of a nail, the shoe is lost, for want of a shoe, the horse is lost, for want of a horse, the rider is lost." High school physics is the nail, the STEM economy is the horse, we Arizonans are the rider. Arizona may soon become a third-tier state!

**How can we help?**
1) Educate school counselors, principals, parents, and policy leaders to the importance of physics. Ignorance abounds!
2) Continue preparing biology, earth science, and chemistry teachers at ASU to teach physics. Only 168 teachers in Arizona are certified to teach physics. We need more.

**THE BOTTOM LINE:** Physics is the #1 shortage area of K-12 teachers – and has the highest turnover because of strains in the system and higher wages in the private sector. Unless our ASU summer program continues to prepare out-of-field “cross-over” teachers, more high schools in Greater Phoenix will stop offering physics, the quality of instruction will deteriorate due to poorly prepared teachers, and the number of students who learn physics will dwindle further. This will harm the economic health of Arizona, which depends on a strong K-12 education that includes robust physics courses.

**What can YOU do?**
* Learn; visit the modeling website, [http://modeling.asu.edu](http://modeling.asu.edu), and scroll to the bottom, in the section called “Arizona Community”.

* Donate to our ASU tuition scholarship fund. The URL is on the flier: http://modeling.asu.edu/MNS/phyChmTchrScholarshi-donors.pdf, and on the ASU Department of Physics website. We are thankful to local companies that contributed: Boeing, Salt River Project, ON Semiconductor, Air Products, Arizona Technology Council. We are especially needy right now, because Boeing in Mesa can’t donate for this summer; their corporate headquarters postponed the application period to summer.

* Donate to one of our two endowment funds. One is for scholarships for teachers, and a brand-new one is to administer & support the programs. I started both, with over $100,000 that my parents left me; also, I am naming ASU as the beneficiary of my retirement accounts. It is easy to donate; it’s an investment in the future of ASU and our community. Linda Raish is a joy to work with. Ask her. There may be an opportunity for a match; contact Linda or me if you’re interested.

When you think about donating, remember the power of education. It is huge! You’re helping committed physics teachers who are called to the profession, like my mother was. Remember, she was an abandoned child. She wrote, “I entered first grade in a one-room school with eight grades, and there I found my place in the world. I was a good student, and a classroom became the place where I felt comfortable and competent. Do you wonder why I always wanted to become a teacher? It’s a decision I’ve never regretted.”

In sum: ASU physics Modeling Instruction is crucial -- for the future of Arizona and humanity. That is most important now, for me!

Resources:
1) Donate to “Improving Physics and Chemistry Teachers Scholarships” endowment fund: http://asufoundation.org/endowmodeling or 480-965-6468 (Linda Raish, Assoc Dev. Dir.).
2) Donate to scholarship fund for this summer: http://asufoundation.org/modeling
3) See a list of donors: http://modeling.asu.edu/MNS/PhyChmTchrScholarshi-donors.pdf
4) High school physics is the chief STEM pathway (research evidence): http://modeling.asu.edu/modeling/STEMpathways-PhysicsAZ.htm
5) The worsening shortage of physics teachers in Greater Phoenix, and ways to alleviate it: http://modeling.asu.edu. Scroll to the bottom, in the section called “Arizona Community”.
A Modeling Approach to Physics Instruction (12 minutes): https://www.youtube.com/watch?v=ENvziGXdsrs
7) Read Jane’s tribute to ASU Prof. Arnold Meister (Meister Book Award of AZ-AAPT): http://modeling.asu.edu/AzAAPT/MeisterArnold-ASUpysichProf.pdf
8) For a 5-page life story of Marjorie Chapman (Jane’s mother), email jane.jackson@asu.edu.