2020 Oersted Medal Presentation: If opportunity doesn't knock, build a door—My path to active dissemination of active learning

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I've had the good fortune to be able to influence the way physics is taught around the world. The influence of a number of very special colleagues, the synergy of events, and a bit of chutzpah have all contributed. I will comment on these factors and also describe what I believe are the essential features of active dissemination of research-validated active learning strategies. © *2020 American Association of Physics Teachers.*

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I. INTRODUCTION

It is a huge honor to me to receive the 2020 Oersted Medal, and I am humbled by the list of Oersted Medalists that I now join. I thank the Awards Committee, the AAPT Board of Directors, and the members and staff of AAPT for recognizing my accomplishments in this way.

It occurs to me that readers might be interested in hearing briefly about the path that brought me to this point and several very special people whom I want to thank sincerely for helping me along the way. Then, I will share some ideas on active dissemination of effective, research-validated active learning strategies.

II. THE BEGINNING

In 1971, I completed my Ph.D. at MIT and joined the Western Illinois University faculty. Coincidentally, Dick Peterson, this year's Melba Newell Phillips Medal awardee, joined the WIU faculty at the same time. A year later, mostly because of budget cuts challenging WIU, I moved to University of Michigan, Dearborn. Part of my responsibilities as the Chair of Physics (within the Natural Science Department) was to develop an undergraduate physics program, which I accomplished with the help of new faculty I hired, including the late Paul Zitzewitz (AAPT Treasurer for a number of years).

At UM-D, I also met Orin Gelderloos, Professor of Biology. Orin is a Field Biologist and Environmental Scientist (see Fig. 1.)

I thank Orin for three very important lessons: (1) Students can be scientists—learning from their observations—even in a course for non-science majors. (2) Demand without compromise that your students work and think. (3) Stick to your convictions about innovative and effective learning strategies, despite ridicule and attacks.

Orin also has a great sense of humor. When I audited his Field Biology class one summer, I noticed how he loved asking students to describe the special adaptations of plants in challenging habitats, like a campus parking lot … *where he had placed them!*

Orin invited me to become the Director of the interdisciplinary, general education science course for nonscience majors, *Matter, Energy and Life (MEL).*[1] Imagine how cocky I felt at 30 years of age becoming Director of *Matter, Energy and Life!* MEL was developed, and team taught by an interdisciplinary team from the Natural Science Department and taken by every non-science major at UM-D, with a total enrollment of 400+ each year. It was hard work and very challenging to a physicist who had studied from K through Ph.D. without a break. It was also lots of fun!

Imagine the challenge of teaching labs on topics like adaptations of weeds to their microhabitats, genetic selection in food plants (by cutting apart fruits and vegetables at the Detroit Eastern Produce Market), and geologic features observed on a drive between Detroit and Ann Arbor. I introduced labs on forms of energy and energy conversion, energy content of food, power and efficiency of electric devices, and energy policy, using a simulator developed by the U.S. Department of Energy[2] (see Fig. 2.)

Based on the materials that I developed for MEL, I contributed my first physics education talk at the joint AAPT/APS Meeting January, 1975, in Anaheim, CA: "Physics in an Integrated, Interdisciplinary Science Course for Nonscience Majors."[3] The late Arnold Aarons was in the audience, neck and face turning redder and redder as I spoke until he raised his hand and scolded, "This is just another of these absurd courses that dumb-down the physics with no attention to effective pedagogy!" I learned that I needed to pay more attention to learning strategies, and not be so

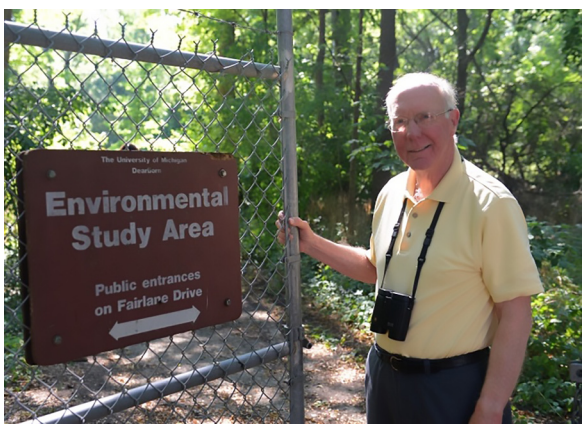

Fig. 1. Orin Gelderloos, Professor of Biology.

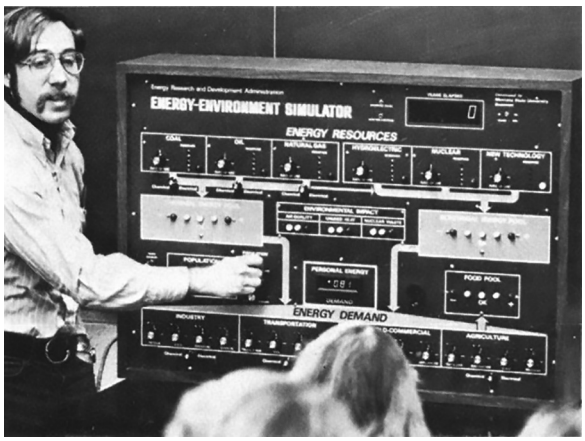

Fig. 2. The author demonstrating the U.S. Department of Energy Energy-Environment Simulator to a class, ca. 1976.

cocky! Besides my talk, MEL resulted in my first publications in *AJP*[1] and *TPT*.[2]

In 1978, I transitioned from Director of MEL and Chair of Physics at UM-D to Associate Department Head at the University of Oregon. (Go Ducks!). It was in 1986 that I first started collaborating with Priscilla Laws of Dickinson College and Ron Thornton of Tufts University (see Fig. 3.)

Like all successful trios, our skills complement each other's very well, and I couldn't ask for two more creative colleagues to work with over the last 33 years! It has been an adventure right from the beginning. Consider our earliest collaboration on what would evolve into *RealTime Physics-Active Learning Labs (RTP)*.[4] In 1986–1987, I was on sabbatical leave at Cal Poly, San Luis Obispo, working cross-country with Ron, using sensors originally developed by Bob Tinker at TERC.[5] I taught two lab sections using borrowed Apple II computers wheeled in each week. Each week I FedExed my labs to Ron for his comments. (There was no e-mail or internet back then!) Each week his comments arrived back the afternoon before the lab meetings, and each week I ran to the printing department, apologized for the last-minute delivery, and promised it wouldn't happen again!?

Also, right from the beginning, we were encouraged by the amazing conceptual learning gains we observed with these lab activities, and the rest is history! The research-validated *RTP* (co-authored with Priscilla and Ron) was first published by John Wiley and Sons in 1999 and has been adopted by over 200 departments (while many others use pre-Wiley, open-source versions). The four modules of *RTP* are in their third edition, with plans for a digital version.[4,6]

Fig. 3. From left to right, the author, Priscilla Laws and Ron Thornton, ca. 1987.

Complementing *RTP*, *Interactive Lecture Demonstrations (ILDs)*[7] were first developed in 1991 to address ineffective traditional instruction in large lectures like those at Oregon and Tufts. The book, *Interactive Lecture Demonstrations*[8] (co-authored with Ron), was published by Wiley in 2004.

III. THE INTERNATIONAL CONNECTION

I didn't really know the late Frank Collea very well, but (likely unbeknownst to him) he had a great influence on my life. On leave from the California State University, Fullerton Physics Department for a significant portion of his career, he was the Project Officer on my first NSF science education grant (1984) and, later, the Co-Director of the NSF National Chautauqua short course program. Frank was never shy bragging about his many accomplishments, and I learned to not be hesitant asking him for what I needed or wanted.

Around 1992, at an NSF Project Directors' Meeting, Frank suggested "You guys should offer a Chautauqua course." Soon thereafter, in a phone conversation, I asked him "When?" In March, 1994, we offered our first $2\frac{1}{2}$ day course "*Promoting Active Learning in Introductory Physics Courses*" at CSU Fullerton. In a phone conversation in 1997, Frank shared "I just sent a Chautauqua team to Hawaii," to which I responded, "When are you going to send *us*?" In June 1998, we offered a course at Kapiolani Community College on Oahu. The year 2019 was the 26th consecutive year that we have offered at least one $2\frac{1}{2}$ day Chautauqua course.

In 1998, Frank bragged "I sent Fred Goldberg, Jim Minstrel, and Alan van Heuvelen to Australia," to which I again responded, "When are you going to send *us*?" In January, 1999, we presented short courses in Sydney and Melbourne. It was at the Chautauqua in Melbourne that I first met Alex Mazzolini, Professor of Physics at Swinburne University, who has been a cherished colleague since then (see Fig. 4.)

Alex is a gifted educator—committed to active engagement with his students—with a keen sense of the needs of educators in the developing world. We discovered immediately that not only did we share a philosophy on the most effective strategies for student learning, but we both enjoyed shopping for "Rolex" watches at Asian street markets, we both enjoyed collecting musical instruments from around the world, and we have very compatible sarcastic senses of humor. I'm very pleased that Alex will be awarded the International Commission on Physics Education (ICPE) Medal (jointly with Pratibha Jolly) at the Third World Conference on Physics Education in Hanoi in July, 2020. Besides reinforcing my convictions about active learning, I thank Alex for modeling how to work effectively with educators from the developing world and for literally opening a world of opportunities for me to pursue this endeavor all over the world.

Alex asked me if we could extend our short course in Melbourne for two extra days to work with a dozen faculty flown in from SE Asia by the Asian Physics Education Network (ASPEN). (Two extra days in Melbourne? That's a no brainer!) As a result of this successful workshop, our style of active learning was adopted by ASPEN and UNESCO, I was invited by Alex to present at an ASPEN active learning workshop in Hanoi, in November, 1999; Ron, Priscilla, and I

Fig. 4. Alex Mazzolini, Australia, is in the center. Other members of the international team for this 2011 ALOP workshop in Nepal are from left to right Ivan Culaba, Philippines; Souad Lahmar, Tunisia; Vengu Lakshminarayanan, Canada; Zohra Ben Lakhdar, Tunisia; and the author.

were invited to present workshops in Chonju, South Korea during Summers 2000 and 2001; and I was invited to present at an ASPEN active learning workshop in Kandy, Sri Lanka in December, 2002.

In May, 2004, Alex and I were invited to UNESCO Paris to consult on a new faculty enhancement project for developing countries—Active Learning in Optics and Photonics (ALOP).[9,10] (A week in Paris consulting with UNESCO? That's another no brainer!) The rest is history. Since 2004, the volunteer ALOP team has presented 37 ALOP workshops (15 in Africa, 10 in Asia, 9 in Latin America, and 3 in Eastern Europe/Eurasia) to over 1100 university and secondary faculty. (Figs. 4 and 5).

IV. ACTIVE LEARNING PROFESSIONAL DEVELOPMENT

Since 1987, my colleagues and I have presented nearly 300 extended active learning institutes, workshops, schools, and short courses attended by over 8000 college/university and secondary faculty. These have been supported by NSF, U.S., and local Departments of Education, Howard Hughes Medical Institute, UNESCO, ICTP, SPIE, and others. Figure 6 shows the participants in the first institute that Ron and I presented together at Tufts during Summer, 1987, the National Microcomputer-Based Laboratory Institute for Teachers of Physics.

From the very beginning, the objectives of our active learning professional development have been:

(1) To introduce faculty to active learning strategies
(2) To model active learning environments
(3) To introduce faculty to computer-based tools for data collection, display, and analysis and modeling and video analysis
(4) To introduce faculty to active learning curricula
(5) To give faculty opportunities to practice the use of active learning strategies, curricula (and tools)
(6) To provide faculty opportunities to "fill the gaps" in their understanding of physics
(7) To introduce faculty to action research using conceptual evaluations
(8) To provide faculty support for implementation of the new strategies (and tools)
(9) To encourage faculty to disseminate active learning to colleagues

To accomplish these, we have incorporated the following components in almost all of our professional development programs:

(1) Each workshop begins with participants taking conceptual evaluation tests. Participants are introduced to conceptual testing and action research and made aware of their students' common conceptual problems *and their own!*
(2) As part of the workshop, participants work through the actual student curricular materials. Participants are familiarized with the equipment and curricular materials and, when necessary, have gaps in their understanding filled.

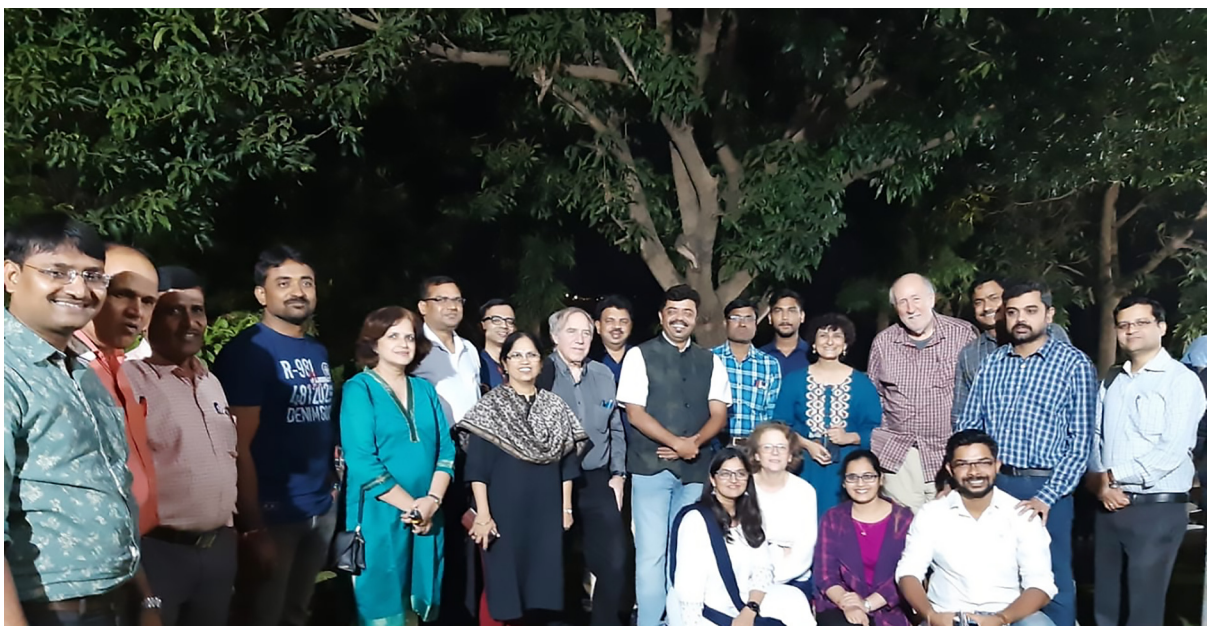

Fig. 5. Participants and facilitators at ALOP in Pune, India, December, 2019.

Fig. 6. Group of exemplary U.S. high school teachers in the Summer, 1987 National Microcomputer Based Laboratory Institute for Teachers of Physics at Tufts University. Ron Thornton and the author are at the left and right ends of the first row.

(3) If time permits, participants are given a chance to practice active learning strategies by presenting to the workshop group. Participants leave the workshop having practiced active learning strategies.
(4) Participants take all the curricula and one complete set of equipment home with them and receive detailed information on procuring or constructing additional sets. Participants leave the workshop with the curricula and equipment that they need for implementation.
(5) Participants are encouraged to share their experiences with their colleagues back home. If possible, there are incentives for "spreading the word."

These features have been adapted to conditions and resources. For example, for ALOP workshops—because of the constraints and cost of international travel—sets of equipment and materials are only distributed to 10 of the 30 participants. The distribution is optimized so that all of the participants will have access to a set and can duplicate the materials locally.

Are Institutes of this type effective? Here is an excerpt from the independent evaluator's Final Report for the NSF-funded Activity Based Physics Faculty Institutes (2005–2008):

> "… given the extremely positive feedback participants gave regarding the workshops and their post-ABPFI experiences with activity-based teaching, combined with the number of faculty trained over the course of four years, it would be hard to describe the ABPFI as anything but extremely successful overall. By the end of the grant period, 170 college instructors had attended an ABPFI workshop. As a result, nearly 20,000 students … many of them members of traditionally underrepresented populations, are able to take advantage of these learning gains … a testament to the ABP group whose members so effectively executed this grant."[11]

V. CONCLUSION

I've been very fortunate in my career to have a number of incredible opportunities available to me. At a recent meeting of the Oregon AAPT Section, my lunch included a cookie with the following fortune inside: "Only those who dare, really live." As I began to contemplate the Oersted Medal address I would give at the AAPT Winter, 2020 Meeting (which is summarized in this paper), I couldn't help but think that my success has come in seizing these opportunities. For me, the fortune might be translated as "*A little chutzpah never hurts along the way!*"

ACKNOWLEDGMENTS

Besides the colleagues I have already mentioned, I would be remiss if I did not thank Lillian McDermott (2001 Oersted and 2013 Melba Phillips Medalist) for the inspiring work that she and her Physics Education Group published beginning in the 1980s and for her personal support in the advancement of my career on a number of occasions. I also thank my partner, Christine Chaillé, an expert in early childhood math and science who studied with Piaget. Besides tolerating my workaholism (she's also a workaholic) and my sarcasm, she's taught me that even young children can be scientists and to be more tolerant and patient. Finally, I want to thank my children, Emily and Jonah, for tolerating—and frequently sharing—my travels over the years, for constantly reminding me why our work in education remains so important, for helping me to stay young and silly, for sharing many exciting adventures with me, and for always bringing me beautiful music!!

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