

## Sixty Years of Astronomy Education: Highlights, and Lessons Learned

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This paper presents some highlights of my 60-year career as an astronomy education practitioner, and why they were significant for me and my students and other audiences. I owe my interest in astronomy education to my outstanding teachers in school and university, and in teachers college, and to my year of experience as a high school teacher. Unlike most university professors, I actually had some training in teaching! Percy (2006) and Percy (2010) are reviews of my understanding of astronomy education.

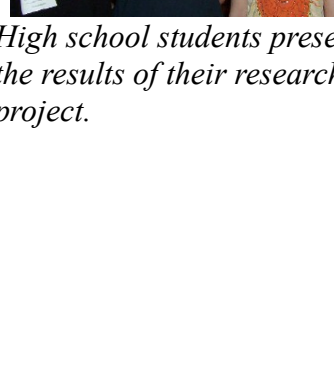
### 1. Building a New University Campus

In 1967, I was fortunate to be a founding faculty member of the University of Toronto's new campus in Mississauga, west of the city (Percy and Abbas 2007, Percy 2016). There, I built up an undergraduate astronomy program, and connected it to the community through school and public outreach. During my five-year term as Dean of Science and Vice-Principal, I co-established TLC: Teaching, Learning, Communication, to help faculty and students develop skills in these areas. I co-established a series of awards to recognize teaching excellence by faculty and graduate teaching assistants.

I also had the opportunity to work with and learn from scholars in other disciplines, which helped me to develop my interest in astronomy's interdisciplinary connections – with the other sciences, and with the humanities and the arts, as discussed below.

### 2. Students as Researchers

My research deals with variable stars and stellar evolution. I quickly realized that students could develop and integrate their skills in STEM, motivated



High school students presenting the results of their research project.

by doing real science with real data. For 25 years, my university also had a program in which talented senior high school students could work on research projects with faculty members. I have supervised over 150 undergraduate and high school students. I assign them small original research projects which they can complete, and which can be published with them as co-authors (Percy 2018). I continue to supervise undergraduates in my “retirement”. Much of the data that we use is obtained by skilled amateur astronomers, working with the American Association of Variable Star Observers (AAVSO). They, like my students, are research colleagues. Their data, software, and other resources are freely available on-line ([www.aavso.org](http://www.aavso.org)).

### 3. International Astronomy Education and Development

I became involved in international astronomy education and development exactly 50 years ago, when I was appointed Canadian representative to IAU Commission 46 (The Teaching of Astronomy). By 1985, I was on the commission's Organizing Committee, and served as President from 1994 to 1997. I participated actively in several of its projects, and travelled widely to meet my “kindred spirits” abroad. I was motivated by experiencing other education systems, by becoming aware of the needs of astronomers in the developing world, and by being able to help in a small way. I co-organized several international conferences, including *The Teaching of Astronomy*, held in Williamstown MA, co-chaired with the late Jay Pasachoff (Pasachoff and Percy 1990), I co-edited the proceedings of five international conferences on astronomy education, in total. I'm delighted to be involved with *AstroEdu 2023*.

### 4. Students as Educators

It is well-known that students can benefit from research opportunities as part of their undergraduate programs. Many universities, including mine, have such opportunities. It's often assumed that most students want to continue in graduate programs and research in their discipline, even though half – or less – do not. Many undergraduate students have a strong interest in education and outreach. I therefore decided to create a Science Education Minor Program which students could combine with their science major (Percy and Abbas, 2007, page xx). I would call the program “STEM Education” if I were creating it today.

The core of the program was a third-year, full-year course in Science Education, and a fourth-year project course in which students carry out projects under the

supervision of a faculty member or other educator. These projects produced

tangible benefits, both to the students, and to the community: school and public outreach events and resources, and archived publications. At its peak, the core course had up to 50 students per year; the project course had a dozen or so. The graduates of the program have gone on to a wide variety of careers, some in education, but all having education as a significant part.

### 5. Astronomy Education Research

Astronomy education should be done using “best practices” determined by research or careful reflection. For the first half of my career, I knew nothing about education research; it did not seem to be happening in my university. There was an Ontario Institute for Studies in Education, a high-powered think tank that was loosely affiliated with the university, and whose staff were “professional” education researchers, but they seemed to resist any involvement from “amateurs” like me.

Finally, in 1996, I connected with OISE through one of their graduate students, Mindy Kalchman. She and some of her fellow graduate students, and faculty colleague Professor Earl Woodruff, began a series of projects with me (e.g. Fong, Percy, and Woodruff 2004; you can find others on ADS). Earl and I co-supervised a PhD thesis in astronomy education research by Nalini Chandra. OISE is now fully linked to the university, doing teacher education and education research. It hosts the Centre for Science, Math, and Technology Education, which I have been a member of for the last two decades. I can also report that the rest of my university is much more strongly involved in education research than before, through its Centre for Teaching Support and Innovation, and through the President's Teaching Academy, of which I am a member. *My advice: try very hard to make connections with those who do teacher education and education research in your university. It can help both you and them!*

### 6. Astronomy in the School Curriculum

I have spoken and written many times about why astronomy should be part of the elementary and secondary school curriculum, and how to make this happen, and why to support teachers when it is (e.g. Percy, 2003). I'm pleased that astronomy is part of the science curriculum in both elementary and secondary school. There are many challenges, not the least of which is the fact that very few teachers have any background in astronomy, or astronomy teaching.

First of all: you should be aware of when the government is going to revise the curriculum. You must then find out (preferably well ahead of time) which group actually creates the curriculum, or reviews it. I have worked on both curriculum development and review. You must then know (also well ahead of time!) which publishers create the textbooks for the science curriculum. You may be able to be a writer, or reviewer; I have been both. Then comes the hard part: supporting the teachers, most of whom have little or no experience in astronomy, or astronomy teaching. I have worked very productively with the Science Teachers Association of Ontario (stao.org). Now we have an excellent national bilingual program to support teachers: *discovertheuniverse.ca*.

### 7. Bringing Astronomy to the Community

As of my “retirement” in 2007, I had given over 350 public lectures, in 19 countries, on 5 continents. I continue to give them, often once a week. Many of them are on university campuses, including my own. But getting to a university campus can be inconvenient and intimidating, especially for underserved populations.

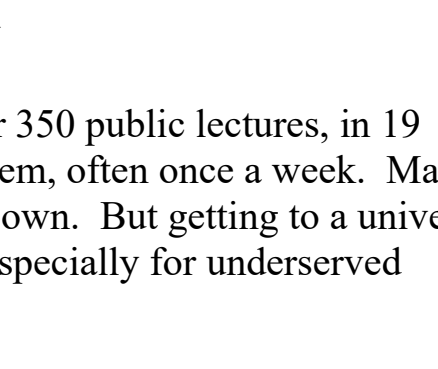
Nowadays, most of my public lectures are in libraries (Percy 2017). The Toronto Public Library, with 100 branches across the city, including in underserved areas, is one of the largest and busiest libraries in the world. The library provides the programming and publicity, the venue and the a-v technology, and the audience. The audiences are relatively small, which allows for lots of questions and discussion.

I have also given several virtual lectures to branches of the Royal Astronomical Society of Canada (RASC), most of whose members are amateur astronomers. It has 30 branches across the country, and has won a major national award for excellence in science outreach. In view of their interest, and voluntary outreach to the public, they deserve our support.

Another frequent audience is later-life learners' organizations, which are also spread across the community. As someone who is later-life myself, I appreciate the importance of keeping mentally and socially active, which these groups do. And they do not hesitate to ask questions and engage in discussion!

### 8. Linking Astronomy and the Arts

Astronomy is rich in interdisciplinary connections, with the sciences, humanities, and arts. One of the highlights of my academic career occurred in International Year of Astronomy 2009, a world-wide celebration of the 400<sup>th</sup> anniversary of Galileo's development and first use of the astronomical telescope. As a long-time fan



Tafelmusik's "The Galileo Project" toured the world to great acclaim.

and supporter of Toronto's famous Tafelmusik Baroque Orchestra, I was aware of their outstanding multimedia concerts. I induced them to create an astronomically-themed program (Percy 2009). It was created by Alison MacKay, and led by the late Jeanne Lamon. I was astronomical advisor. The program toured Canada and the world to great acclaim, winning a major award in Australia. There was also a very effective series of concerts for school classes.

I am constantly attracted and intrigued by astronomy's interdisciplinary connections, and the topics of archaeoastronomy, astrobiology, and astronomical heritage are frequent topics of my public lectures. *So, if you have curricular or extracurricular interests outside of astronomy, consider how you can connect them to astronomy, to the benefit of both.*

### 9. “All in the Family!”

I am fortunate to have been married for 60 years to an outstanding academic and award-winning biomedical researcher, teacher, mentor, and textbook author Professor Emeritus Maire Percy. And our daughter Professor Carol Percy is an equally outstanding academic and multi-award-winning teacher and researcher on the history of the English language. So I learn to co-present from. It was therefore a highlight of my professional and multi-award-winning teacher and researcher on the history of the English language. So I learn to co-present from. “Engaging Students in Research and Scholarship: Three Perspectives” at the 2009 Teaching and Learning Symposium at the University of Toronto! There are so many ways to enrich students' education by going beyond coursework.

**Acknowledgements.** I thank the hundreds of students and other colleagues who have inspired me, and contributed to my work in astronomy education. You have truly enriched my life and academic career.

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