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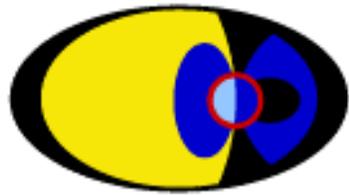
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*Strategies for Scientist Involvement  
in the Preparation of  
Pre-Service Elementary and Secondary Teachers*

March 13, 2005  
Lunar and Planetary Science Conference  
Houston, Texas

**Gregory R. Schultz**

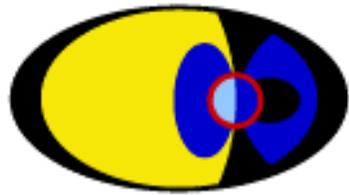
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## My interest and involvement in pre-service teacher education *dates back somewhat:*

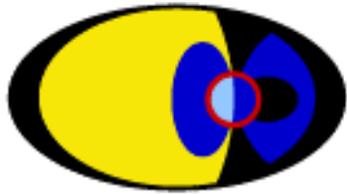
- **1988-1990:** as a Teaching Assistant in *a physics course required of elementary teachers* at Purdue University
- **late 1990s:** as a graduate student completing a PhD in Astronomy at UCLA, especially when preparing a proposal for an NSF Postdoctoral Fellowship in Science, Mathematics, Engineering and Technology Education (PFSMETE)
- **1999-2002:** as an NSF PFSMETE Postdoctoral Fellow at UC Berkeley's Space Sciences Lab, *with a primary focus on pre-service teacher education*
- **2002-present:** as an Education/Outreach Scientist and Teacher Educator continuing at UCB/SSL, and *carrying on pre-service efforts for NASA and SECEF*



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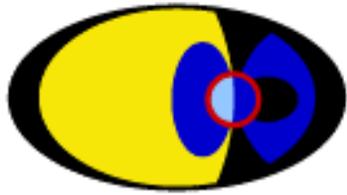
**Making an impact in pre-service teacher preparation is challenging  
and benefits from a multi-faceted approach**

- **Become informed by education research, research-based consensus policy documents, and practical resources such as:**
  - *How People Learn* (NRC, 2000), in particular Chapter 8 titled “Teacher Learning”\*
  - *Educating Teachers of Science, Mathematics, and Technology* (NRC, 2001)
  - *Teaching Teachers: Bringing First-Rate Science to the Elementary Classroom* (from NSTA Press, 2002)
  - *Improving Teacher Preparation and Credentialing Consistent with the National Science Education Standards* (NRC, 1997)
  - *Preparing Tomorrow’s Teachers: Preservice Partnerships Between Science Museums and Colleges* (from ASTC, 1999)
  - *Journal of Science Teacher Education* (from ASTE)
  - *Journal of College Science Teaching* (from NSTA)



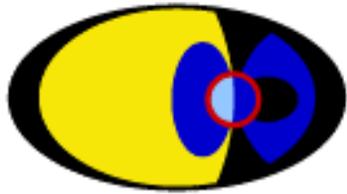
## “Teacher Learning” chapter from *How People Learn*

- Opportunities for Practicing Teachers (to learn about teaching and learning)
- Quality of Learning Opportunities
- Action Research
- **Preservice Education**
  - Preparation of new teachers in pre-service programs is playing an increasingly important role.
  - Considerable structural variation amongst teacher education programs exists in the U.S.
  - There are *common components of teacher education programs*:
    - some subject-matter preparation
    - a series of foundational courses (e.g. philosophy, sociology, history, psychology of education)
    - one or more developmental, learning, and cognitive psychology courses
    - methods (“how to”) courses
    - a sequence of field experiences
  - Some philosophical traditions of practice in teacher education dominate, but programs vary.
  - Program components tend to be disjointed, and taught or overseen by faculty without much communication with each other.
  - Collaboration is underemphasized (vs. team approach to problem-based learning in medical schools).
  - Political factors have strong effects, and hinder innovation in teacher education programs.



## “Teacher Learning” chapter from *How People Learn*

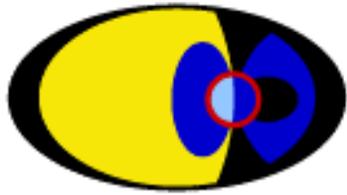
- **Preservice Education (continued)**
  - National Commission on Teaching and America’s Future (1996) identified several current problems:
    - *inadequate time* for students in teacher educ. programs done as part of undergraduate degrees
    - *fragmentation* within teacher education programs: disconnected components and courses
    - *uninspired teaching methods*, lacking hands-on, minds-on experiences
    - *superficial curriculum*, with little depth in subject matter or in educational studies
  - **Pre-service students typically complain that:**
    - foundations courses are “disjointed and irrelevant to practice,” or are “too theoretical”
    - methods courses are “time consuming and without intellectual substance”
  - **These problems mean that *lifelong learning for teachers is impeded in at least two ways:***
    - A message is sent to prospective teachers that education research has little to do with schooling.
    - The importance of viewing themselves as subject-matter experts is not emphasized to teachers.
  - An additional challenge, even for well-prepared student teachers, is **transitioning from college to the teaching world, transferring what one has learned -- from expert learner to novice teacher.**
  - Many **schools that new teachers enter** are set up in conflict with what research shows about learning.
  - **Student teachers see dissonance between their student teaching and teacher education course work.**
  - New teachers are often given the most challenging assignments, partly leading to high turnover rates.



## “Teacher Learning” chapter from *How People Learn*

- **Conclusion**

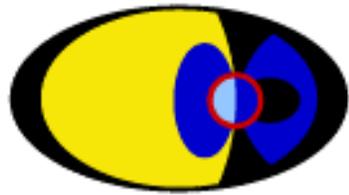
- *Typical teacher workshops* tend to occur once, deal with decontextualized information, and often do not resonate with teachers’ perceived needs. The most successful professional development activities are those that are extended over time, encourage development of teachers’ learning communities, and engage teachers in learning activities similar to ones they will use with their students.
- *Programs for pre-service teachers* need **well-defined goals for learning, beliefs about how people learn that are grounded in theory, and a rigorous academic curriculum that emphasizes depth of understanding.**
- *The potential for teachers’ lifelong learning and development as professionals* is hampered because, **although teachers are urged to use student-centered, constructivist, depth-versus-breadth approaches in their education classes, new teachers often see traditional pedagogy in use at the college level and in classrooms in their schools.**
- *Successful learning for teachers* requires **a continuum of coordinated efforts that range from pre-service education to early teaching to opportunities for lifelong development as professionals.**



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**Making an impact in pre-service teacher preparation is challenging  
*and benefits from a multi-faceted approach***

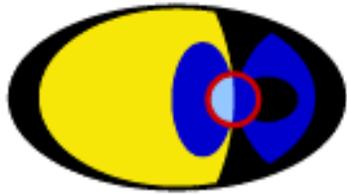
- **Make meaningful connections with the science teacher education community**
  - **Talk with science education faculty** at your university or in your region.
    - In most cases, teacher preparation programs are based in a **School of Education**.
    - But some universities have science education faculty based in **science departments**.
  - **Attend the Annual Conference of the Association for Science Teacher Education (ASTE; [www.TheASTE.org](http://www.TheASTE.org))** – *formerly known as the Association for the Education of Teachers of Science (AETS)*.
    - Plan for **January 12-14, 2006 in Portland, Oregon**.
    - ASTE also holds **regional conferences** (e.g. Feb. '05 in Oklahoma).
    - After attending, listening, and interacting with colleagues, **consider presenting in subsequent years**, perhaps in a collaboration.



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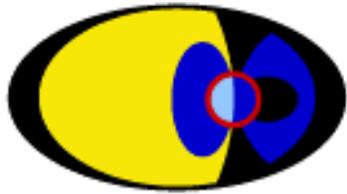
**Making an impact in pre-service teacher preparation is challenging  
*and benefits from a multi-faceted approach***

- **Look into approaches for enhancing either of the following:**
  - **undergraduate science courses with future teachers enrolled** (i.e. most general science courses)\*, noting that many such students may not identify as a prospective teacher quite yet
  - **science teaching methods courses\***
- **When developing and offering **workshops** for in-service teachers, **consider:****
  - **partnering with a teacher educator** in the development of the workshop
  - **recruiting pre-service teachers** and other beginning teachers to join the mix



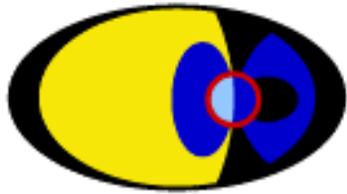
**Activities included in response to survey for the NASA/OSS Pre-Service Working Group**

| <b>Partners</b>  | <b>Target Audience</b>   | <b>Region or location</b>                  | <b>Type of program</b>                                    | <b>Unique aspects (if any)?</b>   |
|--|--|--|---|---|
| Kathleen O'Sullivan  | preservice secondary science teachers (and beginning teachers) | San Francisco State U., and SF Bay Area    | science methods course activities, and regional workshops | direct ongoing partnership between astronomer and science education professor   |
| Kathleen O'Sullivan (and Tim Slater, Isabel Quita, Richard Sedlock, Doug Millar) | science education faculty, other teacher educators             | national conferences in CA, NC, MO, TN, CO | AETS/ASTE conference presentations                        | direct ongoing partnership between astronomer and science education professor (and with diverse set of other teacher educators) |
| Isabel Quita, Ruth Paglierani  | preservice elementary (multi-subject) teachers                 | San Francisco State U.                     | science methods course activities                         | direct ongoing partnership between astronomer and science education professor (and with a primary grades specialist)            |



Activities included in response to survey for the NASA/OSS Pre-Service Working Group

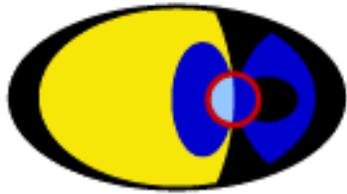
| <b>Partners</b>                       | <b>Target Audience</b>  | <b>Region or location</b>          | <b>Type of program</b>   | <b>Unique aspects (if any)?</b>   |
|---------------------------------------|---|------------------------------------|--|---|
| Ellen Metzger,<br>Richard Sedlock     | preservice elementary and secondary teachers (and inservice teachers) | San Jose State U., and SF Bay Area | Earth and space science content course for preservice teachers, and regional workshops | partnership with geoscience faculty to improve space science components of courses, workshops |
| Adrienne Cool,<br>Kathleen O'Sullivan | preservice elementary and secondary teachers                          | San Francisco State U.             | Astronomy laboratory course activities   | partnership with astronomy professor to improve lab lessons                                   |
| Dave Dempsey,<br>Kathleen O'Sullivan  | preservice elementary and secondary teachers                          | San Francisco State U.             | consultation on design of new interdisciplinary science course for preservice teachers | NSF funding from CCLI program; multi-disciplinary team  |



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|---|---|---|---|--|
| Michael Thibodeau   | preservice secondary teachers (and inservice teachers)                | Lawrence Berkeley Lab (Dr. Thibodeau regularly from Lesley Univ.) | workshop activities for summer intern teachers (both preservice and inservice)                    | Dept. of Energy funding for summer internships for preservice teachers   |
| David Andrews   | preservice elementary and secondary teachers (and inservice teachers) | Fresno State U. (aka CSU-Fresno)                                  | consultation and co-teaching of new summer science course for preservice (and inservice) teachers | CSU-NASA Education Collaborative funding from JPL  |
| Parvin Kassaie, David Andrews, Art Hammon, many CSU faculty | CSU faculty, pre-service teachers (and inservice teachers)            | California State Univ. system and individual campuses; JPL        | CSU-NASA Education Collaborative (*see URL below)   | ongoing ambitious effort intending to make systemic and individual campus changes improving CSU teacher education, utilizing NASA data and resources |

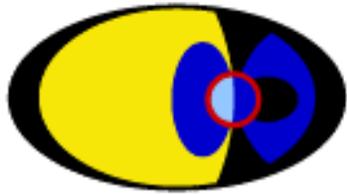
\* CSU-NASA Education Collaborative website: <http://www2.jpl.nasa.gov/csunasa/>



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*Pre-service Teacher Education in  
Undergraduate Science*

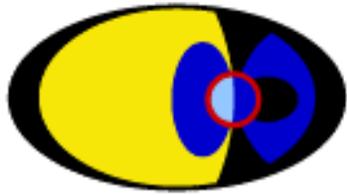
- Collaborated with Prof. **Adrienne Cool**, SFSU Physics & Astronomy department, on *Introduction to Astronomy* course
  - This general education course is *required of all future secondary science teachers*, as per the California Commission on Teacher Credentialing (CCTC) standard for breadth of preparation in the sciences.
- **Lectures and laboratory activities were modified** to incorporate new hands-on experiences, inquiry-based approaches, modeling, and astronomy data collections.
- SECEF and other space science materials/resources were used or adapted, *including*:
  - *The Real Reasons for Seasons GEMS* guide (Gould, Willard, and Pompea, 2000), developed by the Lawrence Hall of Science (LHS) with SECEF
  - Sunspotter telescopes



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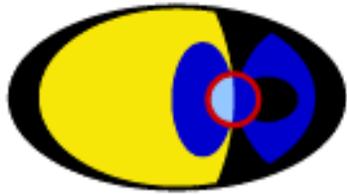
*Pre-service Teacher Education in  
Science Teaching Methods*

- Efforts have involved both **elementary and secondary pre-service teachers**, and partnering with **SFSU science education professors**.
  - Teacher credentialing programs typically have **separate science teaching methods courses** for elementary and secondary teachers.
  - Teacher credentialing programs in California are **primarily post-baccalaureate**, but also include “blended” programs for liberal studies undergraduate majors preparing for elementary teaching.
  - **Students** in methods courses are usually **very mixed**, in both science preparation and in experience with children (tutoring or teaching)
- **Activities and resources have been presented/facilitated** for the students, in guest visits or short “interventions”, **including**:
  - **The Real Reasons for Seasons GEMS guide**, used as an example of a pedagogically strong curriculum unit that especially takes into account students' understandings prior to instruction
  - **Eye On the Sky** activities ([eyeonthesky.org](http://eyeonthesky.org))



## What is the Place for Astronomy & Space Science in *Teacher Education*?

- **Are teachers prepared for basic instruction in astronomy & space science?**
  - Research studies have found that understanding of basic ideas in astronomy and space science tends to be weak.
- **What are teachers expected to know and understand about astronomy & space science?**
  - By inference, one could claim that teachers need to know the astronomy and space science that are included in the state standards for the grades and courses that they teach, at least well enough to be able to provide instruction for their students.
  - Given a coherent system, one would expect to find that the states require undergraduate coursework in astronomy and space science, if they include these subjects in their K-12 standards.
  - However, preparation can still vary widely:
    - some teachers will have a semester of astronomy/space science, with a laboratory
    - some will have just an astronomy/space science course with no lab
    - some take a “geosciences” course that devotes a small portion of the course to astronomy/space science
    - others simply “bone up” and take a subject matter competency test that includes only a few questions on astronomy/space science



## What is the Place for Astronomy & Space Science in *Teacher Education*?

- **What are some reasons for including astronomy & space science in science teacher education?**
  - Or, *How can science teacher educators address the situation described above (and is it worth it)?*
  - Perhaps include some basic concepts of astronomy and space science in science methods courses?
    - Curriculum tends to be full already and it is very challenging to find adequate time
    - But methods courses generally do include the **treatment of inquiry approaches and the nature of science**. Given that pre-service teachers tend to be rather limited in their understanding of astronomy/space science, using these topics in activities can in part improve their appreciation for inquiry.
    - Astronomy and space science have well-documented histories and are rapidly developing disciplines, so these aspects of the nature of science can be illustrated.
    - Many methods courses also **examine curriculum materials**. Excellent resources (e.g. *The Real Reasons for Seasons* GEMS guide) are available which are both learner-centered and use inquiry approaches -- again, a two-for-one solution, as pre-service teachers experience both quality curricula and learn some astronomy at the same time.
    - Finally, there are always **opportunities, funded by NASA and others, for science teachers and science teacher educators to partner with astronomers and space scientists**, enabling mutual professional development along with enhanced science teaching and learning.