

Master of Science Teaching

A Professional Masters degree for educators administered by the Physics and Astronomy Department. Approved by Physics and Astronomy Department, December 5, 2003; approved by Graduate Council January 14, 2003; approved by full Rice University faculty March 17, 2004.

Summary:

A content-based, non-thesis, advanced degree primarily directed towards inservice middle school, IPC (Integrated Physics and Chemistry), Physics, or Astronomy high school teachers and other Education and Public Outreach (EPO) professionals. Thirty credit hours required, of which at least 15 will be content or combination content/tools courses. The remaining credits can either be content, tools, education, research, or practicum, with no more than 12 hours total in research and practicum credits. Each student will have a 3-person committee, with at least two members from the tenure-track faculty, to approve the student's proposed program, advising which specific courses will best suit the student's needs. At least one of the members of the committee will be an experienced Education Professional, who will ensure the appropriateness of the courses to the educator's program. At least one person of the committee will be an expert in the content area that is the student's primary teaching interest. The usual other MS requirements will apply; for example, no more than 9 hours as a Class III student, no more than 6 hours transfer credit, and at least 15 hours at the 500 level and above. The students apply through the Physics and Astronomy Department; GRE's are required. A 3-person committee with at least one Education Professional will review applications. The teachers who finish the program are encouraged to become master teachers in their district, multiplying the impact of the program manifold by giving workshops and other inservice programs to other teachers both in state and across the country.

The Need:

Teachers in Texas are often woefully underprepared to teach science. This underpreparation is demonstrated in the unacceptable student scores in exit tests for science. Elementary school teachers need only 6 hours of science credit for certification, and those can be in non-mathematical sciences. Teachers need additional high-quality courses to improve their content knowledge, and tools to help them use technology in their classrooms. Earth and Space science topics are key in 5th and 6th grade national (as well as Texas) science objectives, and in the corresponding standardized tests, yet many middle school teachers cannot correctly give the reason for the seasons or the phases of the moon! The Masters degree will not only give them required content, it also allows a significant salary increment and an additional professional status.

The National Science Board (NSB), the governing body of the National Science Foundation (NSF), recently released a report on the U.S. science and engineering (S&E) workforce indicating the nation's dependence on foreign-born workers in S&E occupations at a time when the number of H-1B visas issued to these workers is sharply decreasing.

According to 2000 census data, foreign-born workers now represent 17 percent of the total in S&E positions held by people with bachelor's degrees, 29 percent of those with master's degrees, and 38 percent among doctorate holders. NSB members also reported that from 2001 to 2002, H-1B visas for foreign workers in science, engineering, and technology-related fields declined sharply from about 166,000 to around 74,000.

"These trends provide policymakers with the unusual challenge in the coming years of producing enough talent from pools of both U.S. and foreign-educated professionals to fill the important and growing numbers of positions we expect in critical fields," said Warren M. Washington, NSB Chair.

Among the NSB's key recommendations is the need to provide better compensation, in-service training, and support for pre-college teachers of mathematics, science, and technology. The full report, *The Science and Engineering Workforce--Realizing America's Potential*, is at <http://www.nsf.gov/nsb/documents/2003/nsb0369/nsb0369.pdf>.

The National Science Foundation's Division of Undergraduate Education, in its report "Shaping the Future: A report to the National Science Foundation", gives as their number one recommendation to the President and the Congress, that the nation "Establish, in consultation with the higher education community, a new social contract for higher education in America. What is needed may be a new *act* to reconnect the research base of these institutions to the learning of students and to service to the wider community." One of their recommendations to universities is to "Create or strengthen an institution-wide commitment to the preparation of K-12 teachers and principals, bringing together departments of education, SME&T [*Science, Mathematics, Engineering and Technology*] and other departments, K-12 staff, and employers of teachers to design and implement improved teacher preparation programs having substantial SME&T content and stressing rigorous standards, along with emphasis on engaging students in learning." And "Reach out in partnerships with other institutions of higher education, the schools, informal science education organizations, [*e.g. museums and science centers*] and employers to improve SME&T education collaboratively." Their recommendation for Science Mathematics, Engineering and Technology Departments include: "Develop upper division SME&T courses and other educational opportunities appropriate for prospective and current K-12 and two-year college faculty". The NSF is clearly committed to this goal. For more details see the full report <http://www.ehr.nsf.gov/ehr/dued/documents/review/96139/four.htm>.

In the November 2003 issue of *Physics Today*, Neal Lane in his article "The Citizen Scientist" emphasized the importance of scientists giving their time and energy to the public good, much as Benjamin Franklin instituted the volunteer fire department. The importance of supporting K-12 educators was reinforced by Dr. Shirley Macom, Dr. M. R. C.

Greenwood and a distinguished panel at the recent Lane symposium on the Rice campus. The Physics and Astronomy Department has been a leader in support of public education over the past 25 years, and this degree program is an outgrowth of its commitment to educating the next generation of scientists and engineers.

In addition, the technology of Planetariums has increased dramatically in the past few years, and three of the alumni of the former Space Physics and Astronomy Department are now working fulltime in digital Planetariums around the country. This degree, with a practicum at the Houston Museum of Natural Science under Adjunct Professor Carolyn Sumners, could draw additional students who want training in planetarium technology and "Informal Science" (i.e. science taught at science museums). Both NSF and NASA offer grants for programs in "Informal science"; and this degree program would support proposals to those funding agencies.

Rice University already has many programs for K-12 teachers, and an active Outreach Council that helps to coordinate these programs (see <http://www.ruf.rice.edu/~outreach/>). The Outreach Council has discussed this program and will play a role in its oversight, through the participation of Roland Smith, Associate Provost and head of the Outreach Council. Many of the people in the Advisory Council and/or listed as Educational Professionals participate in the Outreach Council.

The Program:

The following are the requirements for the Master of Science Teaching degree. Each student will specify a major area of concentration (e.g. middle school science, Astronomy, Physics, IPC (Integrated Physics and Chemistry), or Informal Science). Each student will work with their committee to create a plan of study that is best able to improve both their content knowledge and their skills. Students also desiring certification must work with the educational certification officer to ensure that their program meets those requirements; however, preservice teachers who desire only certification should apply to the M.A.T. program instead.

Many teacher-focused courses already exist on campus, and if this program is instituted, we will work with the various departments to create or designate other courses as appropriate for the program. High school teachers would be expected to take one or more courses from the regular upper-level Rice offerings, as their schedules permit and their needs demand, but we recognize that most teachers will not have the background to compete in upper division courses.

Content Courses: At least 15 hours in content or content/skills combined courses at the 400 level or above. At least 9 of the hours must be directly related to the student's area of concentration.

Content, Skills or Education Courses: At least 3 additional hours in content, skills, or education courses.

Research or Practicum: Up to 12 hours can be research (educational or scientific) or practicum teaching.

Sample Content or Content/Skills courses already routinely offered for teachers (Many are seminars and may be repeated for credit, since the content changes from year to year):

ASTR 402 (EDUC 588): Teaching Earth and Space Science

ASTR 403 (EDUC 589): Astronomy for Teachers

ASTR 430: Teaching Astronomy Laboratory

TBN: Astrobiology (being taught in spring 2004 as a variant of ASTR 403, will be listed in future years as a separate course, funded by NASA): **Janet Siefert, Statistics & Reiff, P&A**

TBN: The Physics of Ham Radio (presently being taught as a summer workshop under NSF funding, but will probably expand to a full 3-hour course if this degree is approved).

ESCI 508: Dynamic Earth

ESCI 511: Oceans and Atmospheres

Other PHYS or ASTR upper-level content courses, as appropriate

Other NSCI, EDUC, MATH, ESCI or PFDV content courses, if approved by the student's committee and the department

Skills/Practicum/Research courses (sample):

EDUC 413: Theory and Methods of Mathematics

EDUC 415: Theory and Methods of Science

PHYS 800: Graduate Research

PHYS 700: Graduate Teaching

Advisory Council:

The following have participated in planning of this degree and have agreed to serve on the Advisory Council:

David Alexander, Physics & Astronomy
Marjorie Corcoran, Physics & Astronomy
Robert Curl, Chemistry
Neal Lane, Physics and Astronomy
Patricia Reiff, Physics & Astronomy
Ron Sass, Ecology and Evolutionary Biology; Center for Education
Anne Papakonstantinou, Director, School Math Project
Nanda Kirkpatrick, Biochemistry; Director of Precollege Science Education Programs,
Department of Biochemistry and Cell Biology
Carolyn Summers, Houston Museum of Natural Science (Adjunct Professor, Physics &
Astronomy; also halftime, Houston Independent School District)
Roland Smith, Vice Provost for Public Outreach
Gaye Wunsch, Houston Independent School District teacher enhancement programs (ret)

Education Professionals:

The following are involved in working with teachers on a continuing basis and have agreed to serve as the education professional on the teacher committees as appropriate:

Wallace Dominey, Project Director, Center for Education
Nonie Harcombe, Associate Director, Center for Education; Rice Model Lab
Lissa Heckelman, Director, Education Certification Program
Alison Henning, Earth Science Dept (teaches Earth Science courses for teachers)
Siva Kumari, Director of AP programs; Assistant Dean of Continuing Education
Anne Papakonstantinou, Director, School Math Project
Don Perkins, Instructional Technology Consultant, Center for Technology in Teaching
and Learning
Patricia Reiff, Physics & Astronomy
Janet Siefert, Statistics (just received new NASA grant to teach Astrobiology courses)
Carlos Solis, Instructional Technology Consultant, Center for Technology in Teaching
and Learning
Carolyn Summers, Houston Museum of Natural Science (Adjunct Professor, Physics &
Astronomy; also halftime, Houston Independent School District)
Gaye Wunsch, Houston Independent School District teacher enhancement programs (ret)
James Young, ECE (teaches robotics courses for teachers)

Comparable Content-Based (non accreditation) Programs Elsewhere:

(some of these are administered through academic departments, some through Centers for Education, and some through the Schools of Natural Science)

New Mexico Institute of Mining and Technology: Masters of Science Teaching, 30 hours thesis or non-thesis

Eastern Illinois University: Masters of Science in Natural Science (for Teachers): administered by Physics Dept. 32 hours (nonthesis) or 30 hours (thesis), content focus

Illinois State University: Master of Physics Teaching

California State, Chico: Master's of Science Teaching 30 credits, no thesis (9 hours core courses; 12 hours education courses)

Drake: Master of Science in Teaching

Florida State U: Master of Science in Science Education

U Michigan Dearborn: Masters of Science in Science Education

U Wyoming: Master of Science in Natural Science

Portland State Univ: Master of Science in Natural Science

Montana State: Master of Science in Mathematics Education;
Master of Science in Science Education

Stanford: Master of Arts in CTE, Science specialization (also offers a PhD in Science Education)

Stonybrook: Master Degree in Teaching Biology

SUNY: Master of Science in Education (Physics)

U. Maryland: Masters of Arts in Science Education

U. Nebraska: Masters of Science Teaching

U. Washington: Masters of Science in Biology Teaching

U. Georgia: Master of Arts in Science Education

U. Arizona: Master of Arts with Science Specialization

Listing of all professional MS of teaching in mathematics: (over 20 programs listed):
<http://www.math.uic.edu/MER/pages/masters/>

Results of the Pilot Program:

For the past three years, the Physics & Astronomy Department has had a pilot program, with exceptional results. The teachers who entered the program were selected from the many hundreds of teachers who participate in various Rice education programs and classes. Virtually all had taken one or more Rice credit courses and thus Rice faculty were able to give us an excellent differential recommendation of their capacity to do Rice-quality work. They have demonstrated ably the success of the Master teacher program. They have given workshops at National, State and Metro teacher meetings, at the World Space Congress, and at Science Museum meetings. They have given public demonstrations at Sun-Earth Day at the Houston Museum of Natural Science and other events. They were instrumental in working with the crowds on public days at the Rice Observatory associated with the Mars closest approach, often working until 2 am when needing to teach their own classes at 7:30 am. Each has taught over 400 teachers so far, and many more of the general public. They are willing and competent ambassadors of the program. One of our present teachers (Garay) is a state finalist for Teacher of the Year, and one (Furitsch) was a semi-finalist in the Educator Astronaut program. Furitsch tells of several of her students who went from failing science every six weeks to now desiring a career in science. That desire may not last, but it is a clear success of the program.

Rice-trained teachers hold positions of responsibility all across the region. The Space Physics and Astronomy Department has provided (with NSF, NASA, and Eisenhower support) teacher enhancements programs continuously since 1989, and four more grants have recently been awarded to continue into at least the next 5 years. This program was a natural outgrowth of that effort, taken over by the Physics and Astronomy Department when those departments merged in 2000. Alumni of our previous teacher programs include: Janice Arcenaux, who is the head of Science for HISD; Jill Bailer, who finished her Ed.D and is now teaching at the University of St. Thomas; Peggy Halford, head of the Challenger Center at George Observatory; Linda Knight, who works with the Rice Model Lab, and many other leaders in their districts.