

University of Missouri - Columbia
Science Education Center

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GOAL AREAS

1. RESEARCH
2. OUTREACH
3. UNDERGRADUATE EDUCATION
 - Science teacher preparation
 - College science teaching
4. GRADUATE EDUCATION

**MU SCIENCE EDUCATION CENTER ANNUAL REPORT
 JUNE 2006-2007**

The MU Science Education Center (MUSEC) has at the core of its mission (see back cover) to improve science teaching and learning for all. This annual report celebrates the successes of the MU Science Education Center during the 2006-2007 academic year. We highlight our activities aimed at achieving the MUSEC mission in four areas: 1) research; 2) outreach to K-12 schools; 3) undergraduate education, including science teacher preparation and college science teaching; and 4) graduate education. MUSEC was established in 2001 with funding from Mission Enhancement through the collaboration among four MU units: Department of Learning, Teaching and Curriculum (College of Education), Division of Biological Sciences and Department of Physics & Astronomy (College of Arts & Sciences), and the Department of Biochemistry (College of Agriculture, Food and Natural Resources).



MUSEC Director Dr. Sandra Abell works with Missouri science teachers Jan Brown (Blue Springs) and Paula Burkhart (Moberly) at the June, 2006 Teacher Leadership Academy.

MUSEC GOALS

1. To research K-16 science teaching and learning and contribute to the knowledge base in the field. (RESEARCH)
2. To improve K-12 science teaching and learning. (OUTREACH)
3. To improve undergraduate education for science teaching majors, science majors, and non-science majors. (UNDERGRADUATE EDUCATION—SCIENCE TEACHER PREPARATION and COLLEGE SCIENCE TEACHING);
4. To help prepare science and science education graduate students to be active participants in continuing the reform of K-16 science education. (GRADUATE EDUCATION)

RESEARCH

MUSEC Science Education faculty members (6 individuals) had a productive year, with a total of 26 publications: 11 papers in research journals (including the top tier *Journal of Research in Science Teaching*, and *Journal of Science Teacher Education*), 11 papers in practitioner journals (including *American Biology Teacher* and *Science and Children*), 3 book chapters, and 1 book. Nine of these publications included graduate students. In addition, faculty members and graduate students presented their

research at five different national meetings.

Below we highlight three publications—one book and two papers published in the *Journal of Research in Science Teaching*—as examples of the important scholarly work produced by the MUSEC faculty. We also highlight 2 externally funded research projects run out of MUSEC. A full account of our publications and presentations can be found in Appendix A.



GRA Enrique Pareja presents Re-SMAR²T research at NARST.

NSF RESEARCH GRANT FINISHES FIRST YEAR

In April 2006, Professors Abell, Friedrichsen, and Volkmann along with 3 mathematics educators, were awarded a \$2 million dollar grant from the National Science Foundation to study teacher learning in SMAR²T, MU's post-baccalaureate certification program for science and mathematics teachers. The project, known as Re-SMAR²T (www.resmar2t.missouri.edu), hosted a May 2006 meeting of the project's Advisory Board, made up of researchers from

Harvard, Penn State, University of Illinois, University of Wisconsin, and University of Georgia. The Re-SMAR²T team, which also includes 8 graduate student researchers, intensively collected data on the 2006-2007 cohort of future teachers using lesson planning tasks, interviews, observations, and stimulated recall. The team made numerous presentations at national conferences about the project and submitted a manuscript for publication.

GOAL: To research K-16 science teaching and learning and contribute to the knowledge base in the field.

SCIENCE ED. RESEARCH HANDBOOK PUBLISHED

This year saw the publication of the *Handbook of Research on Science Education*, edited by MUSEC's Sandra Abell and her colleague at Illinois Institute of Technology, Norman Lederman. This state-of-the-art compendium provides a comprehensive synthesis of the empirical and theoretical research on teaching and learning in science. Each chapter presents an integrative review of the litera-

ture in a given field of study. Each review pulls together the existing research, analyzes historical trends, describes how the issues are conceptualized, discusses methods and theories that have shaped the outcomes of the research, and locates the strengths, weaknesses, and gaps in the literature. The *Handbook* is an essential resource for science education researchers around the world.



HANUSCIN'S PUBLISHED RESEARCH ON NOS

Akerson, V.L., & Hanuscin, D. (2007) Teaching the nature of science through inquiry: Results of a three-year professional development program. *Journal of Research in Science Teaching*. 44, 653-680.

This study assessed the influence of a 3-year professional development program on elementary teachers' views of nature of science (NOS), instructional practice to promote students' appropriate NOS views, and the influence of participants' instruction on elementary student NOS views. Using the VNOS-B and associated interviews the researchers tracked the changes in NOS views of teacher partici-

pants throughout the professional development program. The teachers participated in explicit-reflective activities, embedded in a program that emphasized scientific inquiry and inquiry-based instruction, to help them improve their own elementary students' views of NOS. Elementary students were interviewed using the VNOS-D to track changes in their NOS views, using classroom observations to note teacher influences on student ideas. Analysis of the VNOS-B and VNOS-D showed that teachers and most grades of elementary students showed positive changes in their views of NOS. The teachers also improved in their pedagogy.



SIEGEL'S PUBLISHED RESEARCH ON ASSESSMENT

Siegel, M.A. (2007). Striving for equitable classroom assessments for linguistic minorities: Strategies for and effects of revising life science items. *Journal of Research in Science Teaching*. 44, 864-881.

Striving for equitable assessments that can contribute to classroom learning for linguistic minorities is a goal of increasing importance as the national population of English language learners continues to rise. This study investigated classroom assessments for English learners in middle school life science courses in two California schools. A framework for equi-

table classroom assessments, McCes - Sounds like Success, was used to refine and evaluate assessments in the study. Ways to improve two written assessments for advanced English learners were developed through teacher research and tested with a pretest/posttest design. Eleven changes to the items were developed, such as adding visual supports and dividing prompts into smaller units. Regression analyses of raw and Rasch modeled data from the pretest/posttest showed that both English only students and advanced English learners scored significantly better on the modified classroom assessments.

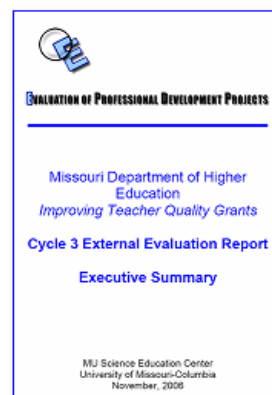
GOAL: To research K-16 science teaching and learning and contribute to the knowledge base in the field.

MU RESEARCHERS EVALUATE STATE ITQG PROGRAM

PI Sandra Abell, along with an interdisciplinary group of investigators, is contracted through 2011 as the external evaluation team for the Missouri Department of Higher Education Improving Teacher Quality Grants (ITQG) program. To date the team has evaluated 27 science and mathematics professional development projects for K-12 teachers in the state of Missouri and produced

reports for Cycles 1, 2, and 3 of the ITQG program. The full reports as well as executive summaries for each cycle can be found at the project website: www.pdeval.missouri.edu.

In addition, the evaluation team has presented its work at the American Educational Research Association and has an article in press in the journal *Studies in Educational Evaluation*.





OUTREACH

The MUSEC is dedicated to improving K-12 science teaching and learning through outreach programs for teachers and students. For example, every spring MU hosts the Missouri State Science Olympiad for middle and high school teams from around the state. Approximately 1000 students compete in over 72 different events. The overall winning team in each division represents Missouri at the National Science Olympiad. MU scientists and science educators also offer a number of outreach programs for

classroom teachers. These programs attract teachers to MU for a day or for a week to learn more science and learn new methods for teaching science.

Because of the need for science outreach, MUSEC has established the Office of Science Outreach and is currently searching for a Director for the office.

In the following sections, several MU science outreach activities are highlighted to demonstrate the breadth of our programs.



Dr. Mark Volkmann works with science teachers at the Teacher Leadership Academy .

SCIENCE TEACHER LEADERSHIP ACADEMY

Each summer since 2004, Professors Abell and Volkmann, along with their mathematics education colleagues, have offered the Science and Mathematics Teacher Leadership Academy (TLA), a 4-day institute for teacher-leaders across the state. Paid for with earmarked funds from the US Department of Education, the TLA is designed to help teacher-leaders develop the knowledge and skills to be change agents in their schools, districts, and regions.

In Summer, 2006, 29 teachers from all parts of the state attended the TLA. They discussed best practices in science and mathematics teaching, learned about leadership theories and strategies, and thought about themselves as teacher-leaders. Each participant produced an Action Plan which was implemented in the 2006-2007 school year. Projects ranged in scope from working within their department to working with teachers across the state.

GOAL: To improve K-12 science teaching and learning.

PREP: AN EXCITING NEW PARTNERSHIP AT MU

In 2007, MU was selected as a dissemination site for PREP: Partnership for Research and Education in Plants, funded through an NSF grant at Virginia Tech. Professors Marcelle Siegel and GRA Deanna Lankford lead MU's PREP site, which brings together 16 high school biology teachers, their students, and 8 MU scientists (Profs. Gassmann, Heese, Liscum, Mitchum, Rogers, Schultz,

Walker, and Zhang). Students design and conduct experiments on *Arabidopsis thaliana*, plants used widely in genetics research (one of the few organisms whose genome has been sequenced), and share their findings with scientists . Students learn standards-based content about plant biology and genetics, as well as standards-based skills related to biotechnology and scientific inquiry.



SKIPS: SUMMER, KIDS, AND SCIENCE

SKIPS: Summer Kids Inquiry Program in Science held its second summer camp in June, 2006. Thirty children, ages 8-10, participated in the 5-day, 15-hour experience called “Shedding Light on Science,” where they investigated properties of light and shadows. SKIPS is the brain-child of Professor Debi Hanuscin, who runs the camp in conjunction with a science education course, “Advanced Methods of Teaching Elementary Science.” For the first three weeks of the course, graduate students read, discuss, and

write about best practices in elementary science education. For the final week of the course, they apply what they have learned as they design, implement, and assess the summer camp. SKIPS is supported by a registration fee that covers the cost of materials and subsidizes scholarships for 5 students from Title 1 schools who are nominated by their principals for the camp. A paper about the program was published by Hanuscin and GRA Kusalin Musikul this year in the *Journal of Elementary Science Education*.



Children participating in an investigation of light in SKIPS 2006.

EXPLORING LIFE SCIENCES AT MU

As part of Life Sciences Week 2007, MUSEC doctoral student Deanna Lankford organized a special day for high school biology teachers and their students. Nine teachers (from Blue Springs, Boonville, Bourbon, Columbia, Fulton, and Moberly) brought 216 students to “Exploring Life Sciences at MU” this past April. Participants listened to research talks by MU scientists Dr. Melissa Mitchum (plant sciences) and Dr. Fred vom Saal (biological sciences), heard MU

graduate researcher Gretchen Pruet discuss agro forestry in Missouri, found about research opportunities for undergraduates at MU from Dr. Linda Blockus, and attended poster presentations sessions highlighting MU life sciences research. According to Stephanie Glenn, biology teacher at Moberly High School, “My students really enjoyed themselves. It was a fantastic experience for all of us.” The day was co-sponsored by the Division of Biological Sciences.

GOAL: To improve K-12 science teaching and learning.

LIFE SCIENCES GRAD STUDENTS GO BACK TO SCHOOL

Biology graduate students Andrew Cox and Katy Klymus established the Life Sciences Graduate Student Outreach program (LSGSO) in 2006. Sixteen graduate students signed up to present their research in interesting and accessible ways to K-12 students in Columbia Public Schools (CPS). Topics included: biology (fungi and pollination), wildlife conservation and behavior (conservation

of tigers, animal communication, human impact on birds), and medical science (diabetes). MUSEC Professors Abell and Siegel gave a workshop for LSGSO about how to engage learners in science. With the support of CPS Science Coordinator, Sara Torres, 5 LSGSO students presented 4 talks, including one to the Biology Club at Hickman High School (www.scienceoutreach.missouri.edu).



Biology graduate students Jenni Geib (left) and Katy Klymus explore owl pellets at the LSGSO workshop.

LESSON STUDY HELPS MAKE PHYSICS FIRST

Columbia Public Schools PI Sara Torres, in collaboration with MU (Drs. Meera Chandrasekhar and Mark Volkmann) and MSU, received \$2 million from DESE to launch Physics First. In Summer, 2006, 70 Missouri teachers attended the first of three academies to learn how to teach conceptual physics in the ninth grade. During the 2006-2007 school year, teachers implemented new curriculum and instructional strategies with the help of a coach mentor and a Professional Learning Team (PLT). Dr. Volkmann su-

pervised the coach mentors and provided guidance for PLTs to conduct lesson study sessions, a form of professional development where teachers collaborate to analyze learning and instruction. Volkmann and PLT members presented their ideas about lesson study at the national meeting of the NSTA in April, 2007. Volkmann and GRA Andrew West also conducted research on the lesson study process which they hope to present in 2008 at the National Association for Research in Science Teaching.



Physics First participants in a lesson study session.

WEATHER WORKSHOP FOR GRADES 4-8 TEACHERS

In Summer, 2006, Dr. Lloyd Barrow and GRA Cathy Wissehr ran a summer workshop for grades 4-8 teachers called *Teaching About Normal and Severe Weather with Inquiry and Literacy*. Funded by the Missouri Department of Higher Education Improving Teacher Quality Grants program (see p. 3), the project affected 25 teachers. Each participant maintained a personal science notebook about weather concepts and activities throughout the 10-day summer

workshop. They used the “four-question strategy” to design inquiry-based instruction for their classrooms. Throughout the school year, they shared their progress at periodic meetings. According to one of the teachers, “Inquiry based lessons have quadrupled in my classes this year. My experiences during the weather class made me feel more comfortable with the whole process, and the new classroom materials gained from our class have helped greatly.”

GOAL: To improve K-12 science teaching and learning.

SCIENCE EDUCATION TAKES ON SPEAKERS CIRCLE

Science education doctoral students Chia-Yu Wang and Kristen Hutchins brought the Missouri Stem Cell Research and Cures Initiative to Speakers Circle last fall. Recognizing that many adults harbor misconceptions about stem cells, the graduate students asked passers-by to participate in a short survey to test their knowledge. Large posters informed respondents about stem cell biology, re-

search applications, and federal laws governing stem cells. Wang, Hutchins, and other students handed out about 150 fliers providing information about stem cells. “People have their beliefs and values, “ said Wang. “Our intention was not to engage in the debate. What we offered was the scientific information rather than the opinions.”

SCIENCE TEACHER PREPARATION

MU Science Education Faculty, as one of their major roles, prepare future of teachers of science for early childhood, elementary, middle school, and high school science teaching. Future high school teachers of biology, chemistry, earth science, physics, or general science take the equivalent of an undergraduate science major as well as course work in education and in science teaching and learning. Our undergraduate middle/high school science teacher preparation program graduates 15-20 new science

teachers each year, while our Master's level alternative certification program (SMAR²T) graduates another 15 per year. Our science teaching and learning courses also serve as sites for research programs about teacher learning and for graduate training in science teacher education. Graduate students serve internships in these courses under the guidance of expert faculty members, learning the philosophies and strategies for teaching future teachers.



Science methods students investigate Bernoulli's Principle.

SMAR²T PROGRAM ADDRESSES TEACHER SHORTAGE

Since its inception in 2003 with funding from the National Science Foundation, the Science and Mathematics Academy for the Recruitment and Retention of Teachers (SMAR²T) has helped address the shortage of science and math teachers in Missouri. Future science teachers enter SMAR²T with an undergraduate degree in a science field. Through this alternative pathway, they can achieve certification in 15 months as a full time student, or in 24 months as a full time

teacher. The 2006-2007 cohort included 20 new students, 13 in science and 7 in mathematics. Of the science students, 3 worked full time as high school science teachers while they completed the certification program.

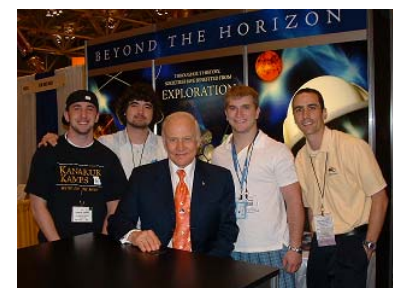
SMAR²T students have been supported through an initial NSF grant and through the Noyce scholarship program, administered by NSF. Graduates are teaching throughout Missouri (see www.smar2t.missouri.edu).

GOAL: To improve undergraduate education for science teaching majors.

NSTA STUDENT CHAPTER GOES TO ST. LOUIS

This past March, the National Science Teachers Association (NSTA), a professional organization of over 55,000 science teachers, held its annual meeting in St. Louis. MUSEC supported conference travel for nine members of the MU NSTA Student Chapter. These students participated in a multitude of professional development workshops. Led by their advisor, Professor Hanuscin, the 33-member

MU NSTA Student Chapter meets monthly to learn new science teaching ideas and serve the local community. At one meeting, Columbia science teacher Marsha Tyson, MU Professor Meera Chandrasekhar, and MUSEC graduate students Mark Gagnon and Pat Brown shared their favorite physics activity and NSTA Chapter members participated in make-and-take activities.

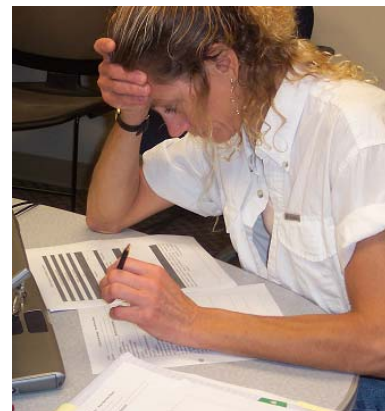


MU NSTA Student Chapter members with former astronaut Buzz Aldrin at NSTA.

COLLEGE SCIENCE TEACHING

A key strategy of MUSEC is to connect science educators with scientists on campus to improve college science teaching and learning. One way we accomplish this is by employing jointly appointed faculty members who teach both science and science education courses (Professors Friedrichsen, Hanuscin, and Siegel). MUSEC also sponsors, in conjunction with the Division of Biological Sciences, Conversations about College Science Teaching, a seminar series devoted to sharing best practices. We of-

fered 9 Conversations in 06-07, by MU science and science education faculty. Topics included how students learn, student feedback, inquiry-based science laboratory instruction, and techniques for large lectures. The “College Science Teaching” course (taught by Professors Abell and Siegel) focuses on the preparation of future college science instructors. A new NSF-funded project, “Connecting Undergraduates to the Enterprise of Science,” aims to insert more inquiry into undergraduate science courses.



Dr. Brenda Peculis (Biochemistry) contemplates how to turn a cookbook lab into inquiry at the CUES summer institute.

CONNECTING UNDERGRADS TO SCIENCE INQUIRY

To extend their proof-of-concept work on inquiry-based college laboratory instruction, PI Frank Schmidt (Biochemistry) and Co-PIs Abell, Adams (chemistry), and Weaver (Env. Studies), were awarded \$500,000 from the NSF for *CUES: Connecting Undergraduates to the Enterprise of Science*. The goal of CUES is to help science faculty and future faculty improve instruction through the use of an innovative inquiry-based laboratory approach—the mini-journal. In Summer,

2007, the first CUES Summer Institute was held with science faculty members from MU, UMKC, Columbia College, and St. Louis Community College and graduate students from MU and UMKC. Participants worked to convert cookbook type laboratories into science investigations where students play a larger role in planning investigations and analyzing results in light of the scientific literature. Participants will implement their labs during the 2007-2008 academic year.

GOAL: To improve undergraduate education for science majors and non-majors.

COLLEGE SCIENCE TEACHING COURSE HIGHLIGHTED

The “College Science Teaching” (CST) course was established in 2001 to address the MUSEC mission of improving college level science education. Since that time, it has become well known across campus. CST is now designated as a “core course” in the Graduate Minor in Teaching. This past winter semester, 16 grad students and 1 postdoc enrolled in CST (taught by Dr. Siegel). Repre-

sented units included Biological Sciences, Molecular Microbiology and Immunology, Chemical Engineering, Chemistry, Biomedical Sciences, Animal Sciences, Plant Sciences, Science Education, Fisheries and Wildlife, Medical Pharmacology and Physiology, and Biochemistry. In 2006, the Department of Veterinary Medicine made CST a “recommended” course for all of its graduate students.

ASSESSMENT IN COLLEGE PHYSICS TEACHING

With the support of a Richard Wallace Research Incentive Grant from the Alumni Association, Dr. Debi Hanuscin led a group of physics faculty and GTAs in learning how to implement assessment-for-learning in Physics 2230: Exploring Principles of Physics. Unlike traditional tests and quizzes, the assessments the team developed were targeted at helping guide instruction and improve student learning. Through studying their own implementation of these assessments, the team found that substantial change in

practice takes time. Instructors must develop facility in implementing new assessments and in using the data to modify instruction. Assessment changes also require students to adjust to unfamiliar teaching approaches. Students' belief that learning is about figuring out what the teacher wants initially served as a barrier to their learning. However, as instructors continued the consistent and deliberate use of formative assessments, students became more skilled in self-assessing their learning processes.

With which, if either, student do you agree? Why?

Student 1: When the bulb is lit, the current flows from the battery to the bulb. There, current is transformed into heat and light.

Student 2: When the bulb is lit, the current flows to the bulb and back to the battery. The electrons flowing in the circuit do not get used up.

Sample formative assessment from Physics 2230.

STUDENT THINKING, BIOCHEMISTRY, AND SOCIETY

Dr. Marcelle Siegel collaborates with Dr. Shari Freyermuth (Biochemistry) to understand student learning and thinking in Biochem 2112: Biotechnology in Society, a course they both teach. In this course, non-science majors learn what can and cannot be accomplished with biotechnology, and investigate the impacts of biotechnology on society. Students typically come into the course with misconceptions, especially regarding stem cells. Supported with an LTC Interdisciplinary

Planning Grant, the research team, which includes GRAs Kristy Halverson and Catharine Clark, studies how students understand and make decisions about stem cell research. They have identified a range of student misunderstandings and redesigned the course pre/post tests to tap into these. They hope to find patterns in student reasoning that will help them structure instruction and assessment to assist students in making informed decisions about stem cell issues.

GOAL: To improve undergraduate education for science majors and non-majors.

A NEW COURSE IN BIOLOGICAL SCIENCES

Dr. Friedrichsen and Chris Pierret, a Biology PhD student, worked together to design and implement a new intersession course, BioSci 2002: Stem Cells & Society. As part of the planning process, they participated in the MU faculty development workshop series, *Difficult Dialogues*. In the Stem Cells & Society course, students examined the basic biology of stem cell research as well as re-

lated legal issues and religious viewpoints. As a major project in the course, students developed personal position papers on human embryonic stem cell research. In a culminating activity, students participated in a community forum in which they shared their viewpoints on stem cell research with invited members of the greater Columbia community.

GRADUATE EDUCATION

The Science Education doctoral program has grown exponentially over the past 5 years. In 2001, the program had 3 full time students, rising to 10 in 2004 and 15 in 2006. These students are supported through teaching assistantships in education and the sciences and through externally funded projects. Two students completed their dissertations in the 2006-2007 academic year.

Science education doctoral students are actively engaged in research, teaching,

and outreach projects. Graduate students were named 31 times as co-authors of papers presented at professional conferences in 06-07, and were named 14 times as co-authors of published papers.

MUSEC supports science education student travel to attend the National Association of Research in Science Teaching meeting, the largest research meeting in the field. Fifteen MUSEC graduate students attended the 2007 NARST.



MUSEC graduate students, staff, and faculty members.

FIRST POSTDOC IN SCIENCE EDUCATION

As part of the CUES project (see p. 8), MUSEC welcomes its first postdoctoral scholar, Dr. Peter Zhao. Peter, who holds a Ph.D. in Chemistry from Wichita State University, joined CUES in January, 2007. In order to learn more about the field of science education, Peter attended graduate courses on inquiry and on college science teaching during the winter semester. To learn more about science

education research, Peter is a regular participant in the Science and Mathematics Education Research Colloquium and in Abell's graduate advisees research meetings. Dr. Zhao has been instrumental in orchestrating the various facets of the CUES project. This fall, new science education doctoral student Steve Witzig will join Peter to work on the CUES project.

GOAL: To help prepare graduate students to be active participants in continuing the reform of K-16 science education.

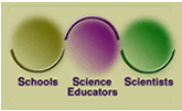
TRANSLATING RESEARCH INTO TEACHING PRACTICE

In 2006, Professor Abell was asked to write a regular column in the NSTA journal for elementary teachers, *Science and Children* (S&C). The Perspectives column shares research on best practices in elementary science teaching in a form useful for classroom teachers. Abell gathered a team of doctoral students to co-write the monthly column. In 2006-2007 the writing team tackled the topics of writing in science, assessment, classroom talk, learning cycle instruction, and

classroom diversity.

Chris Ohana, editor of S&C, wrote to Abell after S&C received the Gold Award (highest honor) for General Excellence in a Scholarly Journal from the Society of National Association Publications: "Sandi, Thanks to your team for their contribution to this recognition. I think the Perspectives column adds a lot to S&C in our attempt to translate research for practi-





**Appendix A:
Faculty Bios and
Publications**

Sandra K. Abell, Curators' Professor

Research Focus: Science Teacher Learning

My research program examines science teaching and learning, K-20. In particular, we study how teachers learn to teach science and how they improve their instruction over time. In the past, we have applied the theoretical framework of conceptual change to teacher learning, studying how future teachers of elementary school science learn science content, form conceptions of the nature of science, and develop their theories of science teaching and learning. We also explored how practicing middle level teachers respond to innovations in teaching science in professional development settings. At the college level, we examined how science faculty reflect upon and change their teaching practice through approaches that involve them as researchers in their own classrooms.

Current projects apply a teacher knowledge framework to understanding science teacher development. In one project, we work with individuals who have decided to become middle and secondary science teachers later in their professional lives following careers in science related fields. In particular, we are interested in how they develop knowledge for teaching and how their s as scientists influence their development throughout the teacher preparation program. In a second project, we are studying how college science instructors go about changing their practice to incorporate inquiry-based teaching strategies into laboratory instruction.

For a list of my current projects, see <http://www.coe.missouri.edu/~abells/>

Recent Publications

Abell, S. K. (2005). University science teachers as researchers: Blurring the scholarship boundaries. *Research in Science Education*, 35(3): 281-298.

Abell, S. K., & Volkman, M. J. (2006). *Seamless assessment in science: A guidebook for elementary and middle school teachers*. Portsmouth, NH: Heinemann.

Abell, S. K., & Lederman, N. G. (Eds.). (2007). *Handbook of research on science education*. Mahwah, NJ: Lawrence Erlbaum.

Park Rogers, M., Abell, S., Lannin, J., Wang, C.-Y., Musikul, K., Barker, D., & Dingman, S. (2007). Effective professional development in science and mathematics education: Teachers' and facilitators' views. *International Journal of Science and Mathematics Education*, 5, 507-532.

Abell, S. K., Lannin, J. K., Marra, R. M., Ehlert, M. W., Cole, J. S., Lee, M. H., Park Rogers, M.A., & Wang, C.-Y. (in press). Multi-site evaluation of science and mathematics teacher professional development programs: The project profile approach. *Studies in Educational Evaluation*.



**Professor
Sandra K.
Abell**



Lloyd H. Barrow, Professor

Research Focus: Elementary Science Education

My research focus has concentrated on ways to improve K-6 science instruction. Specifically, this has involved an analysis of curriculum via professional development and support materials for elementary teachers. Recently, my analysis of magnet trade books continued my study of this topic. Professional development funded projects have utilized inquiry and science notebooks to facilitate specific science concepts.

In addition, my research has examined the employment opportunities of various teacher education specialties. My longitudinal analysis of faculty science education positions provides patterns in higher education employment. Previous research about successful faculty searches is being extended. Faculty productivity at major science education institutions of the 1990s, a base line study, will be forth coming in the *Journal of Science Education and Technology*. A manuscript on female science education researchers of this decade is being prepared.

Recent Publications

Barrow, L. (2006). A brief history of inquiry – From Dewey to standards. *Journal of Science Teacher Education*, 17, 265-278.

Barrow, L., & Germann, P. (2006). A study of science education positions, search processes, and hiring practices. *Educational Research Quarterly*, 29, 52-61.

Barrow, L. (2007). An investigation of portfolio selection by preservice students in two elementary science methods classes. *Eastern Education Research*, 36, 16-21.

Odom, A. & Barrow, L. (2007). High school biology students' knowledge and confidence for diffusion and osmosis concepts. *School Science & Mathematics*, 107, 94-101.

Barrow, L. (2007) Bringing light onto shadows. *Science and Children*, 44 (9),43-5.



**Professor
Lloyd H.
Barrow**

Patricia Friedrichsen, Assistant Professor

Research Focus: Science Teacher Learning



My research is in the area of science teaching and learning (K-16), with emphases in secondary science teacher preparation and biology education. As an educational researcher, I primarily use qualitative research methods. Within the area of teacher learning, I use pedagogical content knowledge (PCK) as a theoretical framework. This framework outlines components of a specialized knowledge base for teaching, which includes knowledge and beliefs about (a) science curricula, (b) students' understandings of science, (c) instructional strategies, (d) assessment, and (e) science teaching orientations. I am particularly interested in the science teaching orientation component, examining how teachers' beliefs influence their teaching practice.

I am Co-PI on an NSF funded project investigating teaching knowledge development in a post-baccalaureate certification program. Prior to this project, I conducted a number of studies on teacher learning. In one study, we examined the formation of teacher identity in an alternative certification program for mathematics and science teachers. The development of a strong teacher identity has been linked to teacher retention. In another study related to teacher retention, we examined the perceived challenges faced by beginning mathematics and science teachers and the support systems they utilize. This study has implications for designing more effective support structures for beginning teachers. In a third study, our research group examined prospective secondary biology teachers' beliefs about the nature of science, their knowledge of evolution, and their intentions to teach evolution. Although the prospective teachers felt prepared to teach evolution, they indicated their decision whether or not to teach evolution would be based on the context of their future school. This study indicates the need for continued mentoring during the induction years to support teachers learning to teach evolution.

For a list of my current projects, see <http://www.coe.missouri.edu/~friedrichsenp/>

Recent Publications

Friedrichsen, P., & Dana, T. (2005). A substantive-level theory of highly-regarded secondary biology teachers' science teaching orientations. *Journal of Research in Science Teaching*, 42(2), 218-244.

Friedrichsen, P., Munford, D., & Orgill, M.K. (2006). Brokering at the boundary: A prospective teacher engages students in inquiry. *Science Education*, 90(4), 522-543.

Friedrichsen, P., Chval, K., & Teuscher, D. (2007). Strategies and sources of support for beginning teachers of science and mathematics. *School Science and Mathematics*, 107(5), 169-181.

Friedrichsen, P., & Pallant, A. (2007). French fries, dialysis tubing & computer models: Teaching diffusion & osmosis through inquiry and modeling. *American Biology Teacher*, 69(2). ABT Online available <http://www.nabt.org/sites/S1/File/pdf/069-02-0031.pdf>

**Professor
Patricia
Friedrichsen**

Deborah L. Hanuscin, Assistant Professor

Research Focus: Science Teacher Learning

My research program examines the epistemological dimensions of science teaching and learning, K-20. In particular, I study how teachers come to understand the nature of science and how their epistemological beliefs about science impact the way science is portrayed in their classrooms. In the past, I have applied the theoretical framework of conceptual change to teacher learning about the nature of science across their program of study, both in their science content courses and education coursework. I have also explored how practicing elementary teachers respond to innovations in teaching the nature of science and inquiry in professional development settings. At the college level, I have examined teaching assistants' views of the nature of science and their learning to teach about the nature of science in laboratory settings.

Current projects apply a pedagogical content knowledge framework to understanding science teacher development and the effective teaching of the nature of science in elementary classrooms. In one project, we are examining the practices of elementary teachers who have successfully improved their students' views of the nature of science. In particular, we are interested in how they develop knowledge for teaching the nature of science and how teacher educators can support prospective teachers in developing their pedagogical content knowledge for teaching the nature of science.

For a list of my current projects, see <http://www.missouri.edu/~hanuscind/>

Recent Publications

Akerson, V. L., & Hanuscin, D. (2005). A collaborative endeavor to teach the nature of scientific inquiry: There's more to science than meets the "I." In R. A. Yager (Ed.) (p. 1-12). *Exemplary science: Best practices in professional development*. NSTA Press: Arlington.

Hanuscin, D., Phillipson-Mower, T., & Akerson, V.L. (2006) Integrating nature of science instruction into a physical science content course for teachers: NOS views of teaching assistants. *Science Education*, 90(5), 912-935.

Akerson, V.L., & Hanuscin, D. (2007) Teaching the nature of science through inquiry: Results of a three-year professional development program. *Journal of Research in Science Teaching*. 44(5), 653-680.

Hanuscin, D. (in press). The use of specialized facilities for laboratory science instruction in elementary schools. In E. Wright, D. W. Sunal, & C. W. Sundberg (Eds.). *Research in science education: The impact of the laboratory and technology on K-12 science learning and teaching*. Greenwich, CT: Information Age.

Varma, T., & Hanuscin, D. (in press) Pre-service elementary teachers' field experiences in classrooms led by science specialists. *Journal of Science Teacher Education*.



**Professor
Deborah L.
Hanuscin**

Marcelle A. Siegel, Assistant Professor

Research Focus: Decision Making; Assessment

Our research approach to problems in science education is based in cognitive theory (the science of individual learning) and sociocultural approaches (the theory of culture and social interaction as it affects development and learning). We focus on science, health, and environmental learning and teaching in middle school, high school, and college. Currently, we have two goals for science education research: 1) to examine cognitive decision making processes, and 2) to study classroom assessment practices and develop resources for teachers to improve assessment practices.

We aim to develop theoretical models of students' scientific decision making and teachers' instructional decision making. Decision making is an essential goal of the National Science Education Standards, yet is rarely learned in science classrooms. Prior work has identified ways of supporting decision making in class and studied the effects of different instructional materials. Research with teachers has refined methods for making teachers' thinking processes visible through the discussion of student work. Currently, we are studying undergraduates' decision making about biotechnology and ethical issues.

Assessments have a large impact on what is learned in a classroom. Assessment practices that support, foster, and monitor learning are essential to an effective classroom. Our work has refined and studied the effects of assessments in middle school life science, with a focus on creating more equitable assessments for English language learners. We are also studying preservice teachers' views of assessment to clarify how understanding develops.

For a list of my current projects, see: <http://web.missouri.edu/~siegelm/>

Recent Publications

Siegel, M.A., & Ranney, M.A. (2003). Developing the Changes in Attitude about the Relevance of Science (CARS) questionnaire and assessing two high school science classes. *Journal of Research in Science Teaching*, 40 (8), 757-775.

Fong, S.R., Siegel, M.A. (2005). Teaching well: Science teachers' investigation and use of student sociocultural background. In D.M. McInerney & S. van Etten (Eds.) *Research on Sociocultural Influences on Motivation and Learning, Vol. 5, Focus on Teaching*, Greenwich, CT: Information Age Publishing, 101-128.

Siegel, M.A. (2006). High school students' decision making about sustainability. *Environmental Education Research*, 12 (2), 201-215.

Siegel, M.A. (2007). Striving for equitable classroom assessments for linguistic minorities: Strategies for and effects of revising life science items. *Journal of Research in Science Teaching*. 44 (6), 864-881.



**Professor
Marcelle A.
Siegel**

Mark J. Volkmann, Associate Professor

Research Focus: Science Teacher Learning

My research program focuses on learning to teach science. In the past I have studied teaching science through inquiry. I investigated my own learning as I taught physics to undergraduate elementary education majors. I studied how a graduate student learned to teach science through inquiry and how undergraduates learned physics through inquiry. I used qualitative methods to understand how individuals made sense of teaching and learning in terms of their orientation to teaching and their professional identity as science teacher.

Currently, I am interested in teacher development throughout their careers. As a member of the Re-SMAR²T team, we use the conceptual framework of pedagogical content knowledge to study beginning teachers. Specifically, I am interested in finding out what knowledge these teachers bring to science classrooms, how they use that knowledge to plan instruction, what they know about student learning, and how they use that knowledge to plan and implement instruction.

In addition, I am investigating how a professional development strategy—lesson study—supports teacher learning at mid-career. I direct the professional development in the *Physics First* project (funded by the Missouri Department of Elementary and Secondary Education) where I lead a group of 9 physics coaches as they interact with 16 Professional Learning Teams (PLTs) across Missouri. Each PLT performs a lesson study cycle, consisting of defining goals, planning a lesson, teaching/observing the lesson, and discussing and re-teaching the lesson. We have preliminary evidence that lesson study can change the way experienced teachers think about teaching.

For a list of my current projects, see: <http://www.coe.missouri.edu/~volkmannmj/>

Recent Publications

Volkman, M. J., & Zgagacz, M. (2004). Learning to teach physics through inquiry: The lived experience of a graduate teaching assistant. *Journal of Research in Science Teaching*, 41(6), 559-579.

Volkman, M. J., Abell, S. K., & Zgagacz, M. (2005). The challenges of teaching physics to preservice elementary teachers: Orientations of the professor, teaching assistant, and students. *Science Education*, 89, 847-869.

Abell, S. K., & Volkman, M. J. (2006). *Seamless assessment in science: A guide for elementary and middle level teachers*. Portsmouth, NH: Heinemann Press.

Abell, S., Boone, W., Arbaugh, F., Lannin, J., Beilfuss, M., Volkman, M., & White, S. (2006). Recruiting future science and mathematics teachers into alternative certification programs: Strategies tried and lessons learned. *Journal of Science Teacher Education*, 17, 165-183.

Arbaugh, F., Abell, S., Lannin, J., Volkman, M., & Boone, W. (2007). Field-based internship models for alternative certification of science and mathematics teachers: Views of interns, mentors, and university educators. *Eurasia Journal of Mathematics, Science & Technology Education*, 3(3), 191-201.



Professor
Mark J.
Volkman



Papers in Research Journals

- Abell, S. K., Lannin, J. K., Marra, R. M., Ehlert, M. W., Cole, J. S., Lee, M. H., Park Rogers, M.A., & Wang, C.-Y. (in press). Multi-site evaluation of science and mathematics teacher professional development programs: The project profile approach. *Studies in Educational Evaluation*.
- Akerson, V.L., & Hanuscin, D. (2007). Teaching the nature of science through inquiry: Results of a three-year professional development program. *Journal of Research in Science Teaching*, 44(5), 653-680.
- Barrow, L. (2007). An investigation of portfolio selection by preservice students in two elementary science methods classes. *Eastern Education Journal*, 36, 16-21.
- Barrow, L., & Robinson, R. (in press). Magnet concepts in trade books- Attracting and repelling concepts. *Journal of Elementary Science Education*.
- Barrow, L., Settlage, J., & Germann, P. (in press). Institutional research productivity in science education for the 1990's: The top 30 ranking. *Journal of Science Education and Technology*.
- Decker, T., Summers, G., & Barrow, L. (in press). The treatment of geologic time and history of life on Earth in high school biology textbooks. *American Biology Teacher*.
- Hanuscin, D., & Musikul, K. (2007) School's IN for summer: An innovative field experience for elementary science methods. *Journal of Elementary Science Education*, 19(1), 57-68.
- Hanuscin, D., Richard, M., Chandrasekhar, M., Corman, A., & Lapilli, C. (2007). Collaborative action research to improve classroom assessment in an introductory physics course for teachers. *Journal of Physics Teacher Education Online*, 4(2), 16-20.
- Odom, L., & Barrow, L. (2007). High school biology students' knowledge and confidence for diffusion and osmosis concepts. *School Science & Mathematics*, 107, 94-101.
- Siegel, M.A. (in press). Striving for equitable classroom assessments for linguistic minorities: Strategies for and effects of revising life science items. *Journal of Research in Science Teaching*.
- Varma, T., & Hanuscin, D. (accepted) Pre-service elementary teachers' field experiences in classrooms led by science specialists. *Journal of Science Teacher Education*.

Papers in Practitioner Journals

- Abell, S. K. (2006). On writing in science. *Science and Children*, 44(4), 60-61.
- Barrow, L. (in press). Facilitating inquiry with the four questions strategy. *Science Activities*.
- Barrow, L., Wissehr, C., & Rotley, C. (2007). Don't forget about inquiry when teaching weather. *The Earth Scientist*, 24(2), 22-7.
- Brown, P. L., & Abell, S. K. (2007). Examining the learning cycle. *Science and Children*, 44(5), 58-59.
- Brown, P. L., & Abell, S. K. (2007). Cultural diversity in the science classroom. *Science and Children*, 44(9), 60-61 .
- Brown, P., Friedrichsen, P., & Mongler, B. (accepted). 2-Liter bottles and botanical gardens: Using inquiry to learn ecology! *Science Activities*.
- Friedrichsen, P., & Pallant, A. (2007). French fries, dialysis tubing & computer models: Teaching diffusion & osmosis through inquiry and modeling. *American Biology Teacher*, 69(2). Published online <http://www.nabt.org/sites/S1/File/pdf/069-02-0031.pdf>
- Gagnon, M. J., & Abell, S. K. (2007). Making time for science talk. *Science and Children*, 44(8), 66-67.
- Hanuscin, D. (in press) The use of specialized laboratory facilities for science in elementary schools: A call for research. *Journal of Elementary Science Education*.
- Lee, M. H., & Abell, S. K. (2007). Assessing for science learning. *Science and Children*, 44(7), 66-67.
- Park Rogers, M. A., & Abell, S. K. (2007). Connecting with other disciplines. *Science and Children*, 44(6), 58-59.



Books and chapters

- Abell, S. K. (in press). Is observation objective? For N. Lederman & J. Lederman (Eds.). *Activities for teaching the nature of science*. Arlington, VA: NSTA Press.
- Abell, S. K., & Lederman, N. G. (Eds). (2007). *Handbook of research on science education*. Mahwah, NJ: Lawrence Erlbaum.
- Abell, S. K. (2007). Research on science teacher knowledge. In S. K. Abell and N. G. Lederman (Eds). *Handbook of research on science education* (pp. 1105-1149). Mahwah, NJ: Lawrence Erlbaum.
- Lederman, N. G., Abell, S. K., & Akerson, V. (in press). Students' knowledge and skill with inquiry. In E. Abrams and S. Southerland (Eds.). *Inquiry in the classroom: Challenges and opportunities*. Greenwich, CT: Information Age Publishing, Inc.

Dissertations completed

- Abdulkadir Demir. (2006, December). *Alternative certification science teachers' understanding and implementation of inquiry-based instruction in their beginning years of teaching*. (Advisor: Sandra Abell) (Dr. Demir is currently a postdoctoral scholar at the University of Toledo, Ohio)
- Kusalin Musikul. (2007, May). *Professional development for primary science teaching in Thailand: Knowledge, orientations, and practices of professional developers and Professional development participants*. (Advisor: Sandra Abell) (Dr. Musikul is currently Academician at the Department of Primary Science, Institute for the Promotion of Science and Technology, Ministry of Education, Thailand)

Refereed papers at professional meetings

- American Educational Research Association, April, 2007
Faculty: Barrow, Hanuscin
Graduate Students: Tsai, Wang
- Association for Science Teacher Education, January, 2007
Faculty: Abell, Barrow, Friedrichsen, Hanuscin
Graduate Students: Brown, Gagnon, Hutchins, Lee
- Interface Conference, February, 2007
Faculty: Barrow
Graduate Students: Brown, Lankford, Wissehr
- National Science Teachers Association (National), April, 2007
Faculty: Abell, Barrow, Hanuscin, Friedrichsen, Volkmann
Graduate Students: Brown, Concannon, Gagnon, Halverson, Hutchins, Lankford, Lee, Musikul, Pareja, Vanmali, Wang, Wissehr
- National Association for Research in Science Teaching, April, 2007
Faculty: Abell, Barrow, Hanuscin, Friedrichsen, Siegel, Volkmann
Graduate Students: Brown, Concannon, Gagnon, Hutchins, Lee, Musikul, Pareja, Vanmali, Wang, Wissehr
- National Professional and Organizational Development in Higher Education Annual Meeting, October, 2006
Faculty: Friedrichsen
Graduate Students: Hutchins

2006-2007
MUSEC
Publications
(continued)



**Appendix B:
2006-2007
MUSEC Grants**

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The MU Science Education Center is dedicated to the improvement of science teaching and learning, K-20, and to the concomitant generation and communication of knowledge about science teaching and learning. The Center accomplishes its mission through the active collaboration among scientists, science educators, and school-based colleagues.

"WORKING TOGETHER TO IMPROVE SCIENCE TEACHING AND LEARNING"

PEOPLE

MUSEC Staff

Director: Sandra K. Abell,
Assistant: Marilyn Estes
Project Coordinator:
Susan White

Office of Science Outreach

(coming soon)

MUSEC Faculty

Lloyd Barrow
Patricia Friedrichsen
Deborah Hanuscin
Marcelle Siegel
Mark Volkmann

Collaborating Faculty

The MUSEC faculty work with scientists and engineers across the MU campus, and with science teachers and leaders across the state.

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