



College of Science  
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## Oregon State University College of Science

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A statewide strategy for enhancing pre-engineering education in Oregon involves improving student achievement in science and mathematics and student appreciation of the central role these domains of knowledge play in a wide range of engineering and engineering-related career pathways. An effective strategy focuses on students and their teachers at **critical transition points** throughout their academic careers<sup>1</sup>. At about the 4<sup>th</sup> grade, students begin building a sense of distinct fields of study most notably in science and mathematics. Academic knowledge, skills and attitudes at the **transition to middle school** impact student motivation, interest, and personal efficacy to persist in science and mathematics classes. A strategy for enhancing pre-engineering education targets student ability and **broadening their options at each educational transition**, to middle school, to high school, to post-high school and college. The College of Science supports many programs that actively enhance the science and mathematics education of Oregon youth.

<http://www.science.orst.edu/outreach.html>

### *Transitions to Middle School and High School*

#### **Department of Science & Mathematics Education**

This Department, situated in the College of Science, is instrumental in fostering collaborations with scientists and engineers that enhance the pre-engineering and applied science pipeline of students. The Department manages a teacher licensure program in addition to masters and doctoral programs in three areas (a) science education, (b) mathematics education, and (c) free-choice learning. Each year the Department graduates over 30 high school and middle level science and mathematics teachers. Students who have majored in a technical field and many who have worked as scientists and engineers, pursue an MS and receive an Oregon teaching license. These teachers are particularly well suited to help students anticipate pathways for scientific and engineering careers. Faculty work with other campus programs such as the College of Education Double Degree, Saturday Academy, SMILE, and Science Connections to deliver courses and programs. The department conducts research into problems affecting the success of student learning, teaching, assessment, curriculum design, and technological applications in K-16 science, mathematics, and engineering classes as well as free-choice learning environments such as museums and science centers.

[http://oregonstate.edu/dept/sci\\_mth\\_education/](http://oregonstate.edu/dept/sci_mth_education/)

#### *Faculty*

- Larry Flick, chair, science education ([FlickL@onid.orst.edu](mailto:FlickL@onid.orst.edu))
- Tom Dick, collegiate mathematics PhD program, mathematics ([tpdick@math.orst.edu](mailto:tpdick@math.orst.edu))
- Rebekah Elliott, mathematics education ([ElliottR@onid.orst.edu](mailto:ElliottR@onid.orst.edu))
- Larry Enochs, science education ([EnochsL@onid.orst.edu](mailto:EnochsL@onid.orst.edu))
- Nam Hwa Kang, science education ([KangN@onid.orst.edu](mailto:KangN@onid.orst.edu))
- Andre Mack, mathematics education ([MackA@onid.orst.edu](mailto:MackA@onid.orst.edu))
- Maggie Niess, mathematics education, emeritus ([NiessM@onid.orst.edu](mailto:NiessM@onid.orst.edu))
- Janice Rosenberg, director of teacher licensure, science education ([RosenbergJ@onid.orst.edu](mailto:RosenbergJ@onid.orst.edu))
- Shawn Rowe, free choice learning PhD program, science education, ([RoweS@onid.orst.edu](mailto:RoweS@onid.orst.edu))
- Emily van Zee, science education ([vanZeeE@onid.orst.edu](mailto:vanZeeE@onid.orst.edu))

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<sup>1</sup> *Great Transitions: Preparing Adolescents for a New Century*, Carnegie Corporation of New York available online [http://www.carnegie.org/sub/pubs/reports/great\\_transitions/gr\\_intro.html](http://www.carnegie.org/sub/pubs/reports/great_transitions/gr_intro.html)

## *Transition to College*

### **Department of Physics**

Faculty are conducting research on the large gap between the way mathematicians on the one hand, and physical scientists and engineers on the other, do vector calculus. With NSF funding, faculty have developed a series of guided group activities emphasizing the geometry of vector calculus, and are in the process of writing an instructors' guide to accompany them.

<http://www.math.oregonstate.edu/bridge/workshops/>

The Department has undertaken an innovative redesign of junior and senior physics curriculum with the aid of NSF funding. The approach teaches physics as physicists think about it, namely in terms of concepts that broadly underlie the various subfields: energy, symmetry, wave motion, rotations and so forth. The new curriculum better serves the needs of all students, from those seeking an applied career to those intending to pursue graduate degrees.

<http://www.physics.oregonstate.edu/paradigms/>

- Manogue, C. A., Siemens, P. J., Tate, J., Browne, K., Niess, M. L. & Wolfer, A. J. (2001). Paradigms in Physics: A New Upper-Division Curriculum, *American Journal of Physics* **69**, 978-990.
- Manogue, C. A. & Krane, K. S. (2003). *The Oregon State University Paradigms Project: Re-envisioning the Upper Level*, *Physics Today* **56**, 53-58.
- Dray, T. & Manogue, C. A. (2003). *Using Differentials to Bridge the Vector Calculus Gap*, *College Mathematics Journal* **34**, 283-290.
- Krane, K. S. (1993). Guest Comment: Women in Physics--A Male Department Chair's Perspective. *American Journal of Physics*, **61**, 393.
- Krane, K. S. (2000). Good Teaching for Good Research. *Physics World* **13**, 14.
- Krane, K. S. (November 2002). What Produces a Thriving Undergraduate Physics Program?, *APS News* **11**, 8.

### **Collaboration with OSU Civil Engineering and Portland Community College**

Framing Student Success is an NSF-funded partnership among OSU Department of Science & Mathematics Education, Portland Community College Building Construction Technology program, selected Portland area high schools, construction industry professionals, and OSU Construction Engineering Management Program. High school teachers work with higher education faculty in designing experiences that help students better anticipate and prepare for technical career options by emphasizing the value and application of skills and knowledge in science, mathematics, and communication. The project is building a model of instructional innovation and career linking with the support of the construction industry that apply broadly to technical career pathways.

<http://www.pcc.edu/services/BCTNSF>

- Flick, L., Cerny, L., Hinkle, S., & Collins, T. (2005). Making Science and Mathematics Meaningful in Career Technical Education. Ft. Worth, TX, School Science & Mathematics Association.
- Flick, L., Collins, T. & Hinkle, S. (2005). Conceiving Life After High School An Evaluation Study of Teacher Perspectives on an Intervention. Paper presented at the meeting of Association for the Education of Teachers in Science, Colorado Springs, CO.
- Flick, L. (2004). A professor looks at the Science Summer Workshop. *Building Futures*,
- Collins, T. & Flick, L. (2004). Teachers Plan Lessons that Link Students to Careers, *Building Futures*,

- Flick, L. & O'Connor, R. (2001). Engineering problems avenues to learning science and math. *The Oregon Science Teacher*, 43, 29-30.

### **Improving Undergraduate Science and Mathematics Instruction**

OSU graduates about 550 in engineering, 450 in science, and 450 in other technical fields. The primary content pathway for these students is through the College of Science. Understanding and improving science and mathematics content instruction has been a major focus of the Oregon Collaborative for Excellence in the Preparation of Teachers (OCEPT). Faculty in the College of Science have participated in instructional and curriculum development associated with this project. Research and evaluation assessing OCEPT effectiveness has been conducted in part by the Department of Science & Mathematics Education.

- Morrell, P.D., Wainwright, C., & Flick, L. (2004). Reform teaching strategies used by student teachers. *School, Science, and Mathematics*. 104, 199-213.
- Flick, L. B. & Lederman, N. L. (2004). *Scientific Inquiry and Nature of Science: Implications Teaching, Learning, and Teacher Education*. Dordrecht, The Netherlands: Kluwer Academic Publishers.
- Wainwright, C. L., Morrell, P., Flick, L. B. (2004). Observation of reform teaching in undergraduate level mathematics and science courses. *School Science and Mathematics* 104, 322-335.
- Park, Y-S., Flick, L. B., Morrell, P. D., & Wainwright, C. (2004), Student teachers and beginning teachers' understandings of scientific inquiry. *Journal of Korean Earth Science Society*, 25, 160-175.
- Wainwright, C. L., Flick, L. B., Morrell, P. (Fall 2003). Development of instruments for assessment of instructional practices in standards-based teaching. *Journal of Mathematics and Science: Collaborative Explorations*, 6(1), 21-46.

### **Collaboration with School of Electrical Engineering and Computer Science**

EECS is fundamentally changing the way we teach engineering concepts to students. Innovating teaching and learning through hands-on platforms for learning. The aim is to put the fun and excitement into EECS and thus retain and inspire interest among students in engineering. Unique to Oregon State and seed-funded by Tektronix, this program helps students understand how class content is interconnected. It also gives them hands-on experience in applying theoretical concepts to their robots, turning theories into realities. Evaluation has been conducted in part by the Department of Science & Mathematics Education.

<http://eeecs.oregonstate.edu/education/tekbots.html>

- Thompson, T., Flick, L., Gummer, E. (2004). Managing curriculum reform: Connecting the familiar with the unfamiliar through design research. Vancouver, BC: National Association for Research in Science Teaching Annual Meeting.
- Fiez, T., Flick, L, Gummer, E., & Thompson, T. (2004). Enhancing Campus Collaborations Through Design Research in Engineering Education Reform. Salt Lake City, UT: American Association for Engineering Education.
- Brown, S., Flick, L., & Williamson, K. (2005). Social capital in engineering education. Frontiers in Education Conference, Indianapolis, IN Oct. 19-22, 2005.
- Brown, S., Flick, L., & Williamson, K. (2005). Student social capital and retention in the college of engineering. Portland, OR: National Association for Research in Science Teaching Annual Meeting.

