National COSEE Network
Professional Development of Educators

The eleven Centers of Ocean Sciences Education Excellence engage in the professional development of educators using several "best practices" models. Central to these programs is the active participation of ocean scientists. What follows is a description of and recommendations for following COSEE effective practices in educator professional development (PD) as identified by research on teaching and learning and individual Center evaluation data. The professional development models for improving the communication of science concepts as tested by COSEE Centers are based on these effective practices.

COSEE PD effective practices rely on three main components:
1) Research - what is known from peer-reviewed literature
2) Evidence - evaluation data related to COSEE Center PD activities
3) COSEE PD tested models and key elements

The following key elements of PD should be included in designing COSEE educator PD activities and programs.

1.) Scientist Recruitment, Participation, and Retention

Scientists assist the National COSEE Network (NCN) in the PD of educators by teaching, leading field and lab exercises, and providing research experiences for educators. The NCN supports scientists by honing their communication skills and conveying their science to educators and the general public. Recommendations for scientist participation in NCN activities include:

- Each Center management team should include at least one active ocean scientist.
- Centers should have an active presence in an oceanographic research institution.
- Ocean science graduate students can serve as graduate assistants to COSEE Centers.
- Scientists should be recruited based upon their willingness to share their research with science educators.
- The professional development activities should meet the educational needs of scientists as well as science educators.
- Scientists should be involved in pre- and post-PD activities, as well as the professional development activities themselves.
- Scientists should receive feedback on their participation.
- Resources developed by the scientists such as posters, concept maps, slide shows, and videos of their presentations should be made broadly available.

2.) Recruiting and Retaining Educators

The NCN continually strives to expand its reach and sustain learning communities of scientists and educators. To achieve this, Centers should:

- Develop an annual educator recruitment plan
- Publish a clear application process with criteria for selection
- Communicate goals and expectations to all participants
- Match scientists' expertise with educators' content needs
- Require educators to sign contracts and/or schools (or districts) to sign memoranda of understanding for educator participation

3,) Ocean Sciences Content Instruction

An essential element of COSEE PD of educators is content instruction in ocean sciences. Key strategies in delivering this content to educators include:

• Utilizing constructivist pedagogy
• Modeling inquiry-based activities, field experiences, research experiences, and other hands-on experiences
• Connecting to participants' previous knowledge
• Addressing misconceptions in science
• Allowing for a diversity of learning styles
• Aligning activities with the national science education standards
• Delivering geographically and culturally relevant content
• Creating a learning community for scientists and educators, sustained with technologies such as list-servs, blogs, and other on-line tools
• Providing access to real scientific data

4.) Recruiting Educators from Underrepresented and Underrepresented Populations

The COSEE Network strives to increase its engagement with educators and scientists from populations underrepresented and underserved in the ocean sciences through innovative partnerships and strategies in recruitment and engagement. Recommendations for broadening participation include:
• Identifying and recruiting role models from underserved populations at all levels - scientists, teachers, students, and the general public – to participate in program activities
• Partnering with minority serving institutions, multicultural organizations, and federal agencies that encourage broader participation in STEM
• Hosting program activities in areas of greater racial and cultural diversity, such as urban and coastal rural areas
• Coordinating activities with greater relevance to underserved audiences and implementing more multicultural strategies that are appropriate for different cultures, genders and abilities
• Identifying contacts that can broker partnerships among diverse organizations
• Tying activities to the families of the students
• Demonstrating active engagement with diverse audiences by integrating individuals from underrepresented populations into staff and advisory boards
• Incorporating local community knowledge and traditional ecological knowledge into ocean sciences content
• Identifying incentives for broader participation in the ocean science workforce

5.) Development of Quality Education Products

Many Centers require both participating scientists and educators to develop products that can be used to produce classroom lessons and activities. Examples include posters, websites, PowerPoint presentations, CD-ROMs, and on-line data and related products. Ensuring that the activities and products are of a high quality requires:
• Educators to adapt existing, tested activities rather than developing new ones, unless the program allows for field-testing of the activities
• Materials to be time-stamped so that Centers can remove outdated products from their databases and websites
• Scientists to be involved in vetting the scientific content of the activities
• Education materials to be made widely available

6.) Transfer of Ocean Sciences Content to the Classroom

The COSEE Centers fill a niche by assisting educators to interpret ocean sciences content and transfer it to their classrooms by:
• Modeling how the content should be delivered
• Mapping the ocean sciences content to the national science education standards

- Demonstrating the personal relevance of ocean sciences
- Engaging science educators with scientists in building scientific explanations and arguments

7.) Post-program Engagement Activities

Centers create communities that are maintained with regular communication. Over time teacher and educator leaders in schools and informal science institutions should be cultivated. These audiences are key in the dissemination of ocean sciences content. Centers should engage participants in post-program activities, including participation in on-line social networking environments.

If participants are required to develop and/or implement ocean sciences education activities or materials, Center staff should "follow-up" with participants to provide guidance, evaluate the effectiveness of the activity implementation, and encourage participants to share with their colleagues. If the participants are master teachers, they should be required to mentor novice educators as part of the program's design.

8.) Evaluation and Assessment

Front-end/needs assessment data are important to gather. Questions should include what do educators already know about the topics to be covered, what are their barriers to teaching it, etc. Formative and summative types of evaluation are also critical. Annual evaluation results must be incorporated into the next year's activities. Other evaluation strategies that are essential for assessing the impacts of COSEE PD activities are:

- A daily reflection process that assists PD providers with gauging the understanding of science concepts and participant needs
- The engagement of evaluators in the activity planning stage
- A focus on how tools/products are being utilized after the PD program
- Participation of evaluators in Center leadership meetings
- Post-program scientist interviews

9.) Mentoring Strategies

COSEE PD programs should include mentoring components as part of the program's design. Mentoring may include several forms such as:

A.) COSEE staff mentoring scientists

- Provide best practices for communicating science knowledge
- Facilitating opportunities to communicate their science

B.) COSEE staff mentoring educators

- Staff presence in classrooms during transfer to the classroom
- Presenting together at conferences
- Publishing collaboratively
- Engaging in on-line environments

C.) Scientists mentoring educators

- Scientists providing research publications for the educators to read pre-PD program
- Scientists and educators presenting together at scientific or education conferences
- Scientists working with educators to write papers for scientific or education journals

D.) Educators mentoring educators

- Participants working together in a workshop
- Teachers serving as leaders in their respective school or school district
- Past participants returning to mentor new participants
- Veteran teachers mentoring novice teachers over a period of time

Exemplary COSEE Professional Development Models

Several models of educator PD are implemented by COSEE Centers. All COSEE PD models should include the participation of ocean scientists, the integration of technology, pre-program orientation for the scientists, reflection time for all participants, the broad dissemination of education materials produced during the program, and post-program "follow-up" with all participants. Four exemplary models field tested by COSEE Centers include:

• Scientist-Educator Summer Institutes

Multi-day (one week to six weeks), face-to-face programs followed by multiple online "follow-up" sessions. Scientists deliver ocean science content through inquiry-based activities and field or shipboard exercises. Post-program, educators are required to develop or adapt education materials, transfer ocean science content to students or the public, and formally mentor colleagues.

• Teacher Research Experiences (TRE)

Multi-day (one week to six weeks), face-to-face field, laboratory or shipboard programs where educators conduct authentic scientific research with scientist partners, followed by multiple online "follow-up" sessions. TREs are preceded by science content instruction for the educators and an orientation for the scientists. Post-TRE, educators are required to transfer ocean science content to students or the public and formally mentor colleagues.

• Scientist-Educator Collaborative Workshops

Multi-day (two to six day), face-to-face programs followed by multiple online sessions. Workshops focus on specific scientific concept(s) or the use of a science education tool. Scientists deliver ocean science content through inquiry-based activities, concept-mapping, and field or shipboard exercises. Post-program, educators are required to develop or adapt education materials, transfer ocean science content to students or the public, and formally mentor colleagues.

• Scientist-Educator On-line Workshops

Multi-day ($\geq$ 2 day), online programs where participants interact in a virtual environment. On-line interaction is preceded by preparation of the educators and scientists to work in the on-line environment. Post-engagement, educators are required to transfer ocean science content to students or the public and formally mentor colleagues.

Literature Used to Develop COSEE Professional Development Activities

American Association for the Advancement of Science. 1993. *Benchmarks for Science Literacy*. New York: Oxford University Press.

Blank, R. and de las Alas, N., 2009. *Effects of Teacher Professional Development on Gains in Student Achievement: How Meta Analysis Provided Scientific Evidence Useful to Education Leaders*. Washington, DC: Council of Chief State School Officers.

Bransford, J., 2000. *How People Learn: Brain, Mind, Experience, and School* (Expanded Edition). Washington, DC: National Research Council.

Bransford, J. and Donovan, S., Eds., 2005. *How Students Learn: History, Mathematics, and Science in the Classroom*. Washington, DC: National Research Council, http://www.nap.edu/catalog.php?record_id=10126

Champagne, A.B. , Kouba, V. L. , and Hurley, M., 2000. *Assessing Inquiry*. In J. Minstral and E. van der Zee (Eds.), *Inquiring into inquiry learning and teaching in science*. Washington, DC: American Association for the Advancement of Science, pp. 447 – 470.

Committee on Science and Mathematics Teacher Preparation, Center for Education National Research Council, 2001. *Educating Teachers of Science, Mathematics, and Technology: New Practices for the New Millennium*. Washington, DC: National Research Council.

Fortner, R. W. and Corney, J. R., 2001. Great Lakes educational needs assessment: Teachers' priorities for topics, material and training. *Journal of Great Lakes Research,* v. 28, no.1, pp. 3-14.

Fortner, R.W., Corney, J.R., and Mayer, V.J., 2005. Growth in student achievement as an outcome of inservice environmental education using Standards-based infusion materials. *Preparing Effective Environmental Educators, NAAEE Monograph 2*. Washington DC: NAAEE.

Guskey, Thomas, R., 2000. *Evaluating Professional Development*. Thousand Oaks: Corwin Press.

Garet, M., Porter, A., Desimone, L., et al., 2001. What makes professional development effective? Results from a national sample of teachers. *American Educational Research Journal,* v. 38, no. 4, pp. 915-945.

Holmes, K.,. Murphy-Shaw, M., Wiggins, G., and Mc Tighe, J., 1999. *What is Backward Design?* http://www.flec.ednet.ns.ca/staff/What%20is%20Backward%20Design%20etc.pdf

Institute of Education Sciences, National Center for Education Statistics, 2002. *The Nation's Report Card: Science 2000*. Washington, D.C: U.S. Department of Education.

Kelting-Gibson, L. M., 2005. Comparison of curriculum development practices. *Educational Research Quarterly*, v.29, no.1, pp. 26-36.

Loucks-Horsley, S. et al. 1998. Designing Professional Development for Teachers of Science and Mathematics. Corwin Press, Thousand Oaks.

Mayer, V.J., Fortner, R.W., Hoyt, W., 1995. Using cooperative learning as a structure for Earth Systems Education workshops. *Journal of Geological Education,* v. 4, no.(4), pp. 395-400.

National Research Council. 1996. National Science Education Standards. Washington, DC: National Academy Press.

Rhoton, J. and Bowers, P., 2001. *Professional Development Leadership and the Diverse Learner*. Arlington: NSTA Press.

Rhoton, J. and Stiles, K., 2002. Exploring the professional development design process: Bringing an abstract framework into practice. *Science Educator*, v.11, no.1, pp. 1-8.

Wiggins, G., & McTighe, J., 1998. *Understanding by Design*. Alexandria: Association for Supervision and Curriculum Development.

Yager, Robert E., Ed., 2005. *Exemplary Science: Best Practices in Professional Development.* Arlington: National Science Teachers Association.