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COSEE Mid-Atlantic

Taking the Pulse of the Ocean
Teacher Professional Development
2003 - 2007

Final Evaluation Report

September 2008

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Overview

The goal of the MACOSEE teacher workshop was to provide teachers with tools, lessons, information, and the motivation to support the integration of real-time data related to the Ocean and the Chesapeake Bay into their science instruction.

COSEE-MA 2005 Teacher

A National Science Foundation goal for COSEE (Centers for Ocean Sciences Education Excellence) is to promote dialog, collaborations and partnerships between research scientists and educators. COSEE Mid-Atlantic tackled this goal, in part, by facilitating scientist-teacher interactions via teacher professional development (PD) workshops designed to train educators in the use of data from ocean observing systems in their teaching. The target educator groups for these PD workshops were middle-school and high-school teachers and the research data were from the mid-Atlantic region, primarily off New Jersey and the Chesapeake Bay.

COSEE Mid-Atlantic (COSEE-MA) conducted a pilot teacher workshop in the summer of 2003, summer workshops with schoolyear follow-up sessions in 2004-2005, 2005-2006 and 2006-2007, and a reunion conference in the summer of 2007. During the summer workshops and follow-up sessions scientists presented their research and many worked with teachers in the field and/or online to collect and understand the research data, educators presented teaching activities, then teachers planned (or presented) how they would incorporate the data into their teaching.

The main purposes of the evaluation of this PD project were:

- to gather data on teacher satisfaction with the workshops and follow-ups to improve the format and usefulness of the content and experience (formative evaluation)
- to determine teachers' application of what they learned during from COSEE-MA experiences (summative evaluation).

Methods

During the summer workshops, the evaluator typically used daily surveys with a mix of questions to measure teachers' satisfaction with the format and content of the professional development provided by COSEE-MA partners and scientists. Early in this project, the evaluator provided daily results within 12 hours to help workshop organizers improve in real time the delivery of the workshop. Later in the project, results were provided to aid with planning subsequent summer workshops.

For follow-up sessions, the evaluator provided session organizers with an end-of-the-day feedback form to collect satisfaction data and gauge teachers' progress on using scientific data in their classrooms. Follow-up results were provided to aid with the planning of future sessions.

To track teachers' application of their learning to their teaching (summative evaluation), the evaluator implemented online surveys (SurveyMonkey.com) during the schoolyear, usually in the winter and late spring. Generally, each online survey was live for up to 3 weeks. During that time, the evaluator sent an email invitation to teachers and at least two reminder emails before closing a survey. In 2006, the evaluator implemented an online survey of all past COSEE-MA workshop participants, and in 2007 moderated a focus group of past participants attending the reunion conference.

The table below shows the dates and formats of the summer workshops and follow-up sessions, the number of teacher participants, and the evaluation methods used.

COSEE-MA Teacher PD Evaluation 2003 - 2007

Workshop Dates	Workshop Format	# of Teacher Participants*	Formative Evaluation	Summative Evaluation
July 6–18, 2003	2-week pilot summer workshop	10	Daily surveys	None
July 11-17, 2004 + follow-ups: Oct. '04 Apr. '05	1-week summer workshop, plus two 1-day follow-up sessions	17	Daily surveys Oct. follow-up session survey & April session video of teacher presentations	Online surveys: Oct. '04 Jan. '05 Jun. '05
July 24- 30, 2005 + follow-ups: Nov. '05 May '06	1-week summer workshop, plus two 1-day follow-up sessions	13	Daily surveys Nov. follow-up session survey & May session video of teacher presentations	Online surveys: Jan. '06 Jun. '06
July 9-15, 2006 + follow-ups: Oct. '06 Apr. '07	1-week summer workshop, plus two 1-day follow-up sessions	14	End-of-week survey Oct. follow-up session survey & April session video of teacher presentations	Online survey: Mar. '07
July 9-11, 2007	2.5-day "reunion" conference	21	End-of-day survey	Focus group at conference (n = 10)

**For this report, we are counting only classroom teachers who participated in the professional development sessions. There were other participants, including COSEE-MA partners and scientists, especially at the 2007 conference.*

This final COSEE-MA report on teacher PD activities includes only those activities evaluated by the COSEE-MA outside evaluator. During the five-year grant, the emphasis of the evaluation work was formative, that is, to help COSEE-MA partners improve their education and outreach activities with teachers. However, we did collect summative data on the COSEE-MA goals of getting more ocean observing system data into middle- and high-school classrooms and reaching out to underserved audiences. The focus of this report is on the summative evaluation results.

Results Highlights

Below are highlights of the results from the summative evaluation of COSEE-MA teacher professional development activities from 2003 to 2007. The full report with more details follows this Results Highlights section.

- Based on teacher feedback on our 2003 pilot workshop and a literature review of “best practices” for teacher professional development (PD), the COSEE-MA team chose to format their teacher PD as a one-week summer workshop plus two schoolyear follow-up sessions that integrated science experiences and classroom applications. Based on teacher data, this PD format proved successful.
- COSEE-MA PD sessions received high satisfaction ratings each year. When asked to compare to other similar experiences, the vast majority of teachers rated both the COSEE-MA workshops and materials as excellent.
- When asked if they had used anything (materials, activities, etc.) from the summer workshop, the percentage who said “yes” usually increased as the year progressed, with most using COSEE-MA materials in the spring. These data argue for a PD format that includes schoolyear follow-up sessions to remind teachers of resources gained during the summer and support the transfer of summer experiences to their classrooms in the spring.
- Involvement in COSEE-MA increased teachers’ use of real-time, or near-real time data, in their teaching.
- Each year we addressed strategies related to teaching “underserved” students about the ocean, beginning in 2004 with resources on the ocean heritage and history of people of color (primarily African Americans/Blacks), and culminating in 2006 with a presentation and discussion on ecosystem health and environmental justice. Although our data indicate some success, this aspect of ocean education needs more attention and more investigation.
- Past workshop participants during a reunion conference conversation identified the keys to success integrating COSEE-MA into their teaching as:
 - the high level of content, materials and access to top notch facilities and scientists—unprecedented in teacher PD according to one teacher
 - the workshop’s mix of scientists’ presentations, field experiences, hands-on activities and online resources
 - field experiences during the workshop that tied to scientists’ presentations, with the scientists often accompanying the group on those field experiences
 - the time during the summer workshop and follow-ups to think about and discuss how the content and activities could be applied to their teaching—the exchange of ideas and building of friendships and support
 - receiving materials needed to conduct activities at their schools (density tanks, etc.)
 - the requirement that by the end of the schoolyear teachers had to present to workshop colleagues and the team what they did in their classrooms with COSEE-MA content and/or materials—this forced them to use what they received, as well as enabled them to learn from one another
 - the responsiveness and continual, positive support by COSEE-MA team members via phone, email and classroom visits
 - the willingness of COSEE-MA team members, in particular women scientists and minority scientists, to serve as role models for teachers and for students
 - the positive way that students reacted to activities, which were hands-on and local, and so real and relevant to students
 - the positive way school colleagues and administration reacted to COSEE-MA—one teacher is now her school’s science department head in part due to COSEE.

Results

Workshop Format

Wow! Top notch activities, speakers, field trips. Excellent use of time. The most efficient, useful scheduling I've ever experienced. I was tired by Thursday, and thought that I would have preferred to end Friday afternoon. But the Friday evening cruise treat/dinner & discussion, then the Sat. morning wrap up helped bring the whole experience together and was most helpful as well.
COSEE-MA 2006 Teacher

COSEE-MA's pilot workshop in the summer of 2003 was two weeks long, held in different locations each week, and organized so that teachers experienced most of the science content and field work during week one and did most of their lesson planning and development work during week two. Although teachers were generally positive about the workshop, this format proved challenging for both participants and workshop organizers/facilitators.

Based on the 2003 workshop's daily teacher surveys, which asked what was useful, what wasn't and what they would change, we determined that the workshop format had several flaws.

- There was not a smooth transition from the first week to the second week (there was a short weekend break between the two). The two weeks appeared to some participants as two workshops: one about doing science and having fun and the other about doing education work. This was due to the separate content focus, changing locations and teaching staff.
- Participants were confused up until the middle of the second week about the final product (lesson plan or classroom application) expected of them. This arose on the first day or two of the workshop and became a major issue on the first day of the second week when they were asked to develop their products.

As part of the review of the pilot workshop and to aid planning for 2004, the evaluator conducted a literature review of "best practices" for teacher professional development workshops (see Appendix 3) and offered recommendations for a workshop reformatting. After many discussions and a lot of work, the COSEE-MA team decided to reduce the summer teacher workshop to one week and add two schoolyear follow-up sessions. They also adopted a daily plan that integrated the science experiences and classroom application work. The new PD workshop format proved to work well for the next three years.

I really think that allowing the teachers to break into smaller groups at the end of each day to discuss what they've learned is something that I really think you should have in next year's workshop. It was great today for us to be able to sit together in smaller groups and really talk about what we would use or what we would change. This workshop has been phenomenal!!
COSEE-MA 2005 Teacher

Out of all of the workshops I have attended this was the only one that included a follow-up workshop. This is extremely helpful, especially in the beginning of the [school] year. It is so busy that we forget some of the things that we've done and it's nice to be reminded in an informal, no-pressure atmosphere. It was also great to see everyone again.
COSEE-MA 2006 Teacher

Meeting again has given us support to make sure that we start implementing RTD [real-time-data]—despite obstacles that we invariably encounter. Making a start is often the hardest part.
COSEE-MA 2004 Teacher

Teacher Satisfaction

I gained more from the week than I expected....I can now speak more fluently about IOOS [Integrated Ocean Observing System] to students and locate them via computer via classroom visuals. I am very excited about the information and interests I can take back to the classroom. Thank you.

COSEE-MA 2004 Teacher

It surpassed my expectations—was the very best one I've attended. I learned more science that was applicable to my classes than ever before. The composition of each day was perfectly balanced. It is obvious that a lot of planning went into bringing in scientists whose presentations were on our level and into finding activities that would be meaningful in our classrooms.

COSEE-MA 2005 Teacher

We had a blast this summer, we learned alot about many new topics. [Organizers] were excellent and had many other excellent people present as well. I loved the beach house and spending time on the boat, everything we did was wonderful!

COSEE-MA 2006 Teacher

It was great getting even more info from the scientists. Also, I got some great ideas from the other teachers. As usual, teachers continue to teach each other.

COSEE-MA 2007 Teacher

Teachers attending COSEE-MA summer PD workshops rated the new experiences and resources highly, as these comments and the data below show.

Q1. Did the workshop meet your expectations? (check one)

	Summer '05 n = 13	Summer '06 n = 14
Response Choices		
yes, definitely	100%	86%
mostly	0%	14%
not sure	0%	0%
not really	0%	0%
no, definitely not	0%	0%

Note: This question was not asked in 2003 or 2004.

Q2. Rate your overall satisfaction with this conference. (circle a number)

	Summer '07 n = 20
Response Choices	
very satisfied 7	50%
6	20%
5	15%
4	10%
3	5%
2	0%
not satisfied 1	0%

Note: This question was only on the 2007 reunion conference survey.

In addition to asking teachers about their satisfaction with their experience, we also asked them to compare it to other similar experiences. As the data show, teachers rated both the workshop and the materials favorably.

Q3. Compared to other professional development workshops that you've attended, how would you rate this one? (check one)

	Summer '04 n = 17	Summer '05 n = 13	Summer '06 n = 14
Response Choices			
excellent	94%	100%	79%
good	6%	0%	7%
fair	0%	0%	7%
poor	0%	0%	7%
awful	0%	0%	0

Note: This question was not asked in 2003.

Q4. Compared to other professional development workshops that you've attended, how would you rate the materials you received? (check one)

	Summer '04 n = 17	Summer '05 n = 13	Summer '06 n = 14
Response Choices			
excellent	88%	92%	86%
good	12%	8%	14%
fair	0%	0%	0%
poor	0%	0%	0%
awful	0%	0%	0%

Note: This question was not asked in 2003.

We were especially interested in whether or not teachers applied their COSEE-MA learning experiences to their teaching. In response to schoolyear surveys, we found that most teachers waited until the spring to teach about the ocean or local environment, and so when asked if they had used anything from the summer workshop, the percentage who said yes usually increased as the year progressed (see table below). Note: The June '06* data below is from an online survey of all teachers who had participated in past COSEE-MA workshops. Although data indicate that use of workshop materials had dropped over time, use among survey respondents was still fairly high.

Q5. Have you used any COSEE-MA [MACOSEE] materials (activities, websites, lessons, ideas, games, etc.) from the "Taking the Pulse" summer workshop so far [this year]?

Response Choices	2004 Teachers			2005 Teachers		'03 & '04 Teachers	2006 Teachers	
	Oct. '04 n = 16	Wntr '05 n = 17	June '05 n = 14	Jan. '06 n = 10	June '06 n = 10	June '06* n = 14	Oct. '06 n = 9	Mar. '07 n = 8
yes	56%	82%	100%	60%	90%	64%	100%	100%
no/ not yet	44%	18%	0%	40%	10%	21%	0%	0%
not sure	—	—	—	—	—	14%	—	—

These data argue for a PD format that includes schoolyear follow-up sessions. Such sessions remind teachers of resources gained during the summer and support the transfer of summer experiences to their classrooms especially when they're ready during the following spring.

Teacher Use of Ocean Data

COSEE is a wonderful opportunity to extend learning beyond the lab and textbook. Being able to access models, animation and real-time or near real-time data will give students the "Why do we need to learn this?" answer.

COSEE-MA 2003 Teacher

Teachers used a variety of materials and activities from the summer COSEE-MA workshops. Across the three years, the activities that teachers cited most often as those used in their classrooms were:

- Globe Toss (Lawrence Hall of Science: <http://www.lhs.berkeley.edu/>)
- Density tank activity
- Gulf Stream Voyage (Stevens Institute of Technology: <http://www.k12science.org/curriculum/gulfstream/index.shtml>)
- CoolClassroom (Rutgers: <http://www.coolclassroom.org/home.html>)
- Hatch to Catch (Bigelow Lab: http://www.bigelow.org/hatch_to_catch/)
- GNOME and/or PORTS (NOAA: <http://response.restoration.noaa.gov/index.php>)

Note: For details, visit the individual websites and the COSEE-MA website: <http://www.cosee-ma.net/education/index.htm>

However, one of our original goals was to engage teachers, and their students, in the study of the ocean or coast through real-time, or near-real-time, data (for brevity, RTD), primarily those provided by scientists via the Web. (*Note: According to the four COSEE-MA annual scientist surveys, 70 to 80% of ocean scientists said they contributed data or content to public websites, and this consistently has been their number one education & outreach activity.*) To track teachers' use of RTD, we asked them at different times during the year and in different ways.

Q6. Did your involvement in the "Taking the Pulse..." workshop increase your use of real-time, or near-real-time, ocean-related data in your classroom [with your students]?

	2004 Teachers	2005 Teachers		'03 & '04 Teachers	2006 Teachers
Response Choices	June '05 n = 14	Jan '06 n = 10	June '06 n = 10	June '06* n = 14	Mar. '07 n = 8
yes, definitely	71%	30%	60%	46%	25%
somewhat	29%	30%	20%	38.5%	50%
not really / not yet	0%	40%	10%	8%	25%
no, definitely not	0%	0%	10%	8%	0%

**Note: This was an online survey following up with 2003 & 2004 participants.*

Q7. As compared to this time last school year, are you using more real-time or near-real-time ocean data with your students?

	2005 Teachers	2006 Teachers
Response Choices	Nov. '05 n = 9	Oct. '06 n = 9
yes, a lot more	22%	11%
yes, some more	33%	56%
yes, a little more	11%	11%
no, none yet	33%	22%

Note: This question was only asked at two schoolyear follow-up sessions on the end-of-the-day feedback forms.

Q8. Have you used any other [non-COSEE-MA] online (website) real-time, near-real-time or archived ocean data with your students?

	2004 Teachers			2005 Teachers		'03 & '04 Teachers	2006 Teachers
Response Choices	Fall '04 n = 16	Win '05 n = 17	June '05 n = 14	Jan '06 n = 10	June '06 n = 10	Jun'06* n = 14	Mar. '07 n = 8
yes	21%	67%	64%	50%	60%	38%	20%
no	79%	33%	21%	50%	40%	23%	40%
not sure	0%	0%	14%	—	—	38%	40%

*Note: This was an online survey following up with 2003 & 2004 participants.

Based on these results, we found that involvement in COSEE-MA increased teachers' use of real-time, or near-real time data, in their teaching. Across the three years, the data that teachers cited most often as those used in their classrooms were:

- NOAA National Weather Service, including hurricane data
- local weather data
- lunar, solar and tide tables
- USGS (U.S. Geological Survey, especially earthquakes and volcanoes)
- COOLroom & COOLclassroom (Rutgers Coastal Ocean Observatory Lab)
- CBOS (Chesapeake Bay Observing System).

Over the years, the top data websites didn't change. It looks as if teachers used them more/more often in response to the workshop training. We did see a bit of a shift in observatory data sources, from New Jersey ocean data at the beginning of this project to Chesapeake estuarine data at the end of the project (which the evaluator believes reflected a shift in the team members who developed and taught the workshops).

The results also indicate a possible decrease in the classroom use of RTD by subsequent teacher classes. We recognize a gap in the data set (no data were collected at the end of the 2007 schoolyear from 2006 teachers). Without those data we cannot conclude that the 2006 teachers used less RTD in their classroom. However, their usage in March was much lower than usage at the same time of year by 2004 and 2005 teachers. The decrease in use may have been due to the 2004 Indian Ocean tsunami and the devastating 2005 Atlantic hurricane season, followed by fewer catastrophic events in 2006. It may also have been due to greater emphasis toward the end of this project on real data (field and classroom experiences), as opposed to online data.

Reaching Underserved Audiences

I have students research [a] scientist of their own ethnicity. They enjoy this and it shows all the students that people from all over the world have contributed to scientific discoveries.

COSEE-MA 2005 Teacher

My ESL and special education students benefited from the hands on and computer related activities. Some of my students from South America brought in things from their homeland to share with the class. It brought everyone together and really showed our similarities to each other instead of focusing on our differences. Rich or poor, black or white, together we learned that ocean links us all together. It is a global bond.

COSEE-MA 2005 Teacher

One of the national COSEE goals is to reach out to “underserved” audiences, this is, to ensure that groups underrepresented in the ocean sciences have improved access to ocean-science education and research results. COSEE-MA took several approaches to address this need.

One of the criteria for selecting teacher participants for COSEE-MA workshops from the pool of applicants was the racial/ethnic diversity of their student bodies. We asked for those data on teachers’ applications. Teachers working in schools with greater than 60% minorities received priority consideration. As a result, even though nearly all of our teachers were white, we were able to reach a diverse group of middle- and high-school students.

We knew, though, that the selection of teachers was not enough. Our research and advice from those teaching in multicultural settings informed us that we needed to address what and how ocean sciences were taught. And so each year we presented issues and strategies related to teaching “underserved” students about the ocean. Our efforts began in 2004, when the COSEE-MA team provided teachers with resources on the ocean heritage and history of people of color (primarily African Americans/Blacks), and culminated in 2006 with a presentation and discussion on ecosystem health and environmental justice.

We received mixed results from these efforts.

Q9. Have you been able to use or develop any materials/activities to help connect underserved students (including minorities, females, those with special needs, etc.) to the ocean or ocean sciences?

Response Choices	2004 Teachers			2005 Teachers		'03 & '04 Teachers	2006 Teachers
	Oct. '04 n = 16	Wntr '05 n = 17	June '05 n = 14	Jan '06 n = 10	June '06 n = 10	June '06* n = 14	Mar. '07 n = 8
yes	0%	33%	93%	40%	50%	30%	50%
no	36%	67%	7%	20%	50%	70%	38%
not yet	64%	—	—	40%	—	—	12%

*Note: This was an online survey of 2003 & 2004 participants.

Honestly, not very much. Although, that was one of my favorite topics of the workshop. Definitely don't take it out of your agenda. If I have extra time at the end of the year I'd like to do something with that. As a teacher and just a participating citizen I learned valuable information. It was an excellent part of the week.

COSEE-MA 2006 Teacher

One of the barriers encountered was time, which is always an issue for teachers trying to add new content to their already packed curriculum. Another issue was the belief by some teachers that just teaching ocean content to minority students was sufficient to connect them to the ocean or ocean sciences.

My classes are 90% 'minority' students. Everything I've done to expose them to marine environmental science applies.
COSEE-MA 2005 Teacher

Research on minority and multicultural education indicates that greater success is achieved by changing teaching strategies, providing role models and supporting the pursuit of "non-traditional" interests, which include the ocean sciences. Some teachers were successful in changing how they related to students while teaching ocean science.

In discussions about the Pfiesteria hysteria, it became apparent that our students closely identified with the MD watermen. Many of these men and women are of color and all of them enjoy a distinctly different culture. Some of my students have parents who are watermen.
COSEE-MA 2006 Workshop Participant

In addition, to supplement the information provided during the workshops, African-American COSEE-MA team members visited teachers at their schools and spoke with their students.

Eric and Erica [COSEE-MA graduate students] paid us a lovely visit at the beginning of the year after the students took Eric's survey. [They] prepared a presentation from their responses so Eric could address their concerns. Very eye-opening for them and caused a lot of discussion and interest. Both are wonderful speakers and really keep the children's interest.
COSEE-MA 2005 Workshop Participant

Although our data indicate some success regarding this aspect COSEE's goals, this certainly needs more attention and more investigation.

Keys to Success: A Conversation with COSEE-MA Teachers

At the July 2007 *Taking the Pulse of the Ocean "Reunion"* Conference, the evaluator met with a group of 10 teachers who had attended past COSEE-MA workshops (1 from 2003, 1 from 2004, 3 from 2005 and 5 from 2006). The conversation focused on one question: What about COSEE-MA (workshops, materials, people, etc.) influenced you to bring this into your classrooms?

The keys to success with integrating COSEE-MA into their teaching were:

- the high level of content and access to top notch facilities and scientists—unprecedented in teacher PD according to one teacher
- the workshop's mix of scientists' presentations, field experiences, hands-on activities and online resources
- field experiences during the workshop that tied to scientists' presentations, with the scientists often accompanying the group on those field experiences
- the time during the summer workshop and follow-ups to think about and discuss how the content and activities could be applied to their teaching—the exchange of ideas and building of friendships and support
- receiving materials needed to conduct activities at their schools (globes, density tanks, eutrophication kits, etc. and all the instructions)
- the requirement that by the end of the schoolyear teachers had to present to their workshop colleagues and the COSEE-MA team what they did in their classrooms with COSEE-MA content and/or materials—this forced them to use what they received, as well as enabled them to learn from one another
- the responsiveness and continual, positive support by COSEE-MA team members via phone, email and classroom visits
- the willingness of COSEE-MA team members, in particular women scientists and minority scientists, to serve as role models for teachers and for students
- the positive way that students reacted to activities, which were hands-on and local, and so real and relevant to students
- the positive way that school colleagues and administration reacted to the materials and activities—one teacher is now her school's science department head in part due to COSEE.

I enjoyed reporting back how the COSEE material was beneficial to my curriculum. More importantly, sharing the materials and ideas that my peers had was wonderful. I came away with so many new ideas my head is spinning. I am very excited to return to school with new ideas and information. COSEE brought new ideas and excitement into my classroom. My students enjoyed using the RTD in class and exploring new opportunities to learn. Inquiry-based lessons are essential to a science classroom and COSEE provided me with the tools and knowledge to do that. I have enjoyed being here and I hope that your program will continue. The fact that we can spend time with "real scientists" is a tremendous asset. It is wonderful to know that you are supportive of what we do in the classroom. Too often we hear negative comments and that can be difficult to deal with on a daily basis. Your continued support and allowing us to have access to you on a one-to-one level is very beneficial. I walk away with a renewed sense of teaching, confidence, pride in what I do and most importantly lifelong friends and colleagues. Thank you!

COSEE-MA 2007 Reunion Conference Teacher

A Final Observation

The results from teachers participating in COSEE-MA illustrated many successes. What does not appear in these data is the failure (as observed by this evaluator) of the COSEE-MA team to work well as a team and support one other in a collaborative effort. I believe my observation is important to mention here because the lack of teamwork resulted in stress among some teacher participants and all of the COSEE-MA team, and often wasted the best talents of team members.

In my opinion the initial clashes were due to several factors:

- different disciplines and cultures (education and science)
- different education philosophies (constructivist and cognitive learning theories) and a lack of agreement on quality teaching strategies
- a lack of agreement on target audience (teachers of middle school, high school, both)
- a lack of agreement on science data sources (online data or real data, ocean or estuary)
- a lack of agreement on outcomes for teacher participants, that is, what they should do with what they gained from COSEE-MA.

What started as a clash of worldviews, decayed into a clash of personalities. The result was animosity and minimal respect for each other's unique experiences and abilities. I am not sure how this could have been resolved (although I've offered a few recommendations below). I do believe that if team members had been able to resolve these differences, COSEE-MA's success with teachers could have been greater than those reported here.

Recommendations

Teachers' recommendations (during the reunion conversation) were to:

- Continue with the current format of the summer workshop and follow-up sessions
- Continue the contact with scientists
- Continue the affordability of this program for teachers and the provision of materials to use in the classroom
- Continue to support the implementation of materials and activities in classrooms, as well as providing role models for teachers (during the workshop) and students (at school)
- Offer an exchange program between COSEE-MA teachers and other COSEE PDs
- Reach other teachers with the most successful materials/activities by publishing a booklet.

The evaluator also recommends (based on the data and observations):

- When bringing together a team with different experiences and philosophies, start with an agreement on the meaning of "quality education" and "effective teaching strategies" grounded in the current research literature (not just team members' experiences).
- From the start agree on the target audience and goals and outcomes (a group logic model may help this process).
- Plan teacher professional development based on a review of the current research literature, as well as team experiences, to be more effective and prevent the proverbial "reinventing of the wheel."
- In addition to providing teachers with the latest science content, also provide teachers with the latest on how students learn related to that content.
- Model for teacher participants "best practices" in terms of teaching techniques.
- On a relatively long-term funded project, such as this, plan for tracking specific outcomes from teachers and possibly students over multiple years.

Appendices

APPENDIX 1
SURVEY INSTRUMENTS

This report includes a few of the questions asked on the many surveys used to evaluate COSEE-MA teacher workshops.

*For a copy of any of the survey instruments used, please contact
Chris Parsons at cp@word-craft.com*

APPENDIX 2 ACKNOWLEDGMENTS

The evaluator would like to graciously thank all of the COSEE-MA participating teachers who took the time to provide us with their thoughtful comments and ideas on how to improve our teacher professional development efforts and activities. The data they provided have been insightful and invaluable. And, working with everyone has been a pleasure.

The evaluator also thanks Deidre Gibson of Hampton University for serving as the onsite evaluation facilitator at many of the workshops and follow-up sessions.

APPENDIX 3
BEST PRACTICES FOR TEACHER PROFESSIONAL DEVELOPMENT

Literature Review
Jan. 16, 2004

Recommendations

Based on my review of the current literature, effective teacher professional development includes all or many of these...

- define who your target audience is (not just grade level, but also phase of professional career and any content/skill prerequisites)
- state outcomes (what teachers are to gain from the workshop/course AND supposed to do back at school)
- base the content on state ed standards and/or local reform initiatives and strategic plans (so teachers will be supported by administrators and districts)
- build on teachers' prior knowledge—their current science knowledge, skills and attitudes (front-end evaluation)
- develop teachers' knowledge of science content through immersion in process AND pedagogy (how best to teach the content and set up student learning environment) AND lab or technology skills (if they need them to teach the content) AND assessment skills (how they will know this works with their students)
- model exemplary pedagogy throughout the workshop/course (teach with methods you expect teachers to use; teachers should experience the content in a way that is similar to what their students will experience)
- base course pedagogy (methods) on the best available research on what works with students AND discuss the pedagogy you're modeling with teachers
- involve teachers in reflecting, practicing and planning what they are to do in their classrooms
- address teachers' concerns about change (initiation, implementation and institutionalization)
- establish a community of learners among teachers by:
 - offering a longer, sustained program (intensive initial training, 1 to 6 weeks suggested) AND regular follow-ups (for up to 3 years)
 - offering opportunities for leadership as agents of change
 - choosing several teachers from same schools, grades, districts, etc., to work together
 - offer incentives and make teachers accountable
 - gain outside support (administrators, schools, parents, community)
 - have teachers assist with the redesign & improvement of the workshop/course (formative evaluation)

These recommendations for effective professional development are based on researchers' and practitioners' review of the literature and professional organizations' standards, but they caution that most published data are self-reports (what teachers say are the most effective methods for professional development). Few studies have looked at the ultimate measure of effectiveness—the impact on students. (That's because it is so difficult and costly to gather the empirical data.) Studies that have linked professional development with student outcomes (specifically Cohen & Hill 1998 & 2000; Kennedy 1998, 1999; Wenglinsky 2002) state that effective professional development includes

- developing teachers' knowledge AND teachers' pedagogy
- providing follow up and support
- helping teachers accommodate diversity and promote equity among students with culturally diverse backgrounds and limited English proficiency.

References

- Note: I could have listed many more individual projects, studies and publications for this topic, but included only these because they offered the best overviews and were the basis for the list above.* CP (2002). New study reports how math and science teachers increase their own knowledge and skills. *AERA News*. Jan. 28. [This news release is regarding an article by Garet, M. et al. (2002). [title unknown.] *American Educational Research Journal* 24(4).
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