THE AMNH *SEMINARS ON SCIENCE* PROJECT: LESSONS LEARNED FROM PHASE I 1999-2002

Executive Summary

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I. INTRODUCTION

In 1999, the AMNH launched an ambitious effort to create on-line science courses for K-12 educators that would immerse them in exciting science topics and give them access to the Museum's scientific resources (scientists, research, expeditions, collections, and exhibitions). This project, called Seminars on Science, has completed a four-year phase of research and development in which 8 new science courses were created and taught on line. Two hundred and seventy-one people have completed courses for credit, and another 131 have audited the courses.

This report captures the lessons learned from this development phase of the SOS project. It addresses three questions:

- What is distinctive about the SOS course model? In what ways does this model have potential to address important problems in education?

- In what ways have SOS courses enhanced teacher knowledge and classroom teaching? What is their potential to make further contributions to science teachers and science teaching?

- What can we learn about the approach the AMNH has taken in developing the SOS project? How might this approach serve as a model for others engaged in educational innovation?

II. SOS AS A MODEL THAT ADDRESSES PROBLEMS OF EDUCATION AT THE INTERSECTION OF THREE DOMAINS

The SOS project represents an important attempt to work at the intersection of three distinct domains:

- The professional development of science teachers, within current standards-based reform efforts
- The role of informal institutions in supporting education reform
- Design and implementation of on-line learning

Each domain has its own institutions, practitioners, and research base; each also has sets of educational problems to address. How can teachers gain the knowledge and skills they need to teach science in a way that is true to the discipline? How can science-rich institutions—museums, aquaria, and zoos—bring their resources to bear on problems within the formal education system? How can teachers be members of learning communities at a distance?

Data associated with the following outcomes are from mid-course and end-of-course on-line and email surveys of course participants, interviews with course participants, focus groups with scientists and guides, and critical reviews of the courses by participants and independent experts.

Outcomes to date

➢ *Teachers' professional development in science*

o The courses developed by the SOS project are effective at providing teachers with authentic learning experiences. This substantiates teachers' need for, and the value of, first-hand learning in science.

o The SOS courses demonstrate that scientifically rigorous courses can be made to be both engaging and accessible for K-12 teachers.

o AMNH scientists who are actively conducting research in the field create and co-lead the courses, thus bringing world-class expertise to the enterprise.

o SOS courses not only add to teachers' science content knowledge, but also provide teachers with resources and activities they can use for their teaching. This suggests that courses focused on authentic science (as opposed to pedagogy *per se*) can be relevant and useful to classroom practitioners.

- *The role of science-rich institutions in supporting science learning and teaching in schools*

- The museum has created courses that are built around two of its distinctive human and material assets—AMNH scientists carrying out scientific investigations, and curated exhibits.

- The ongoing and intensive participation by AMNH scientists demonstrates the commitment to teaching that is present in many scientists working in science-rich institutions.

- The SOS program has learned to involve scientists in ways that tap their expertise but do not overburden them. The SOS collaborative process has brought out the best in diverse museum staff, and has opened up new avenues of professional growth for them.

- By providing careful training and on-line teaching experience to the diverse and numerous course leaders (scientists and guides), the SOS program is building its capacity to provide professional development.

- The content of the courses arises from the science-rich assets of the AMNH rather than being constrained by the demands of the formal education system. This means SOS courses have a depth and authenticity that teachers immediately recognize.

- *On-line learning: creating professional learning communities*

- Technical issues can easily obstruct the teaching and learning process. Careful prototyping has been important to course development.

- The pedagogy of on-line professional development has both similarities with and differences from that of in-person teaching. SOS scientists and guides have mastered this pedagogy well enough to offer courses that are interactive, engaging, and rigorous.

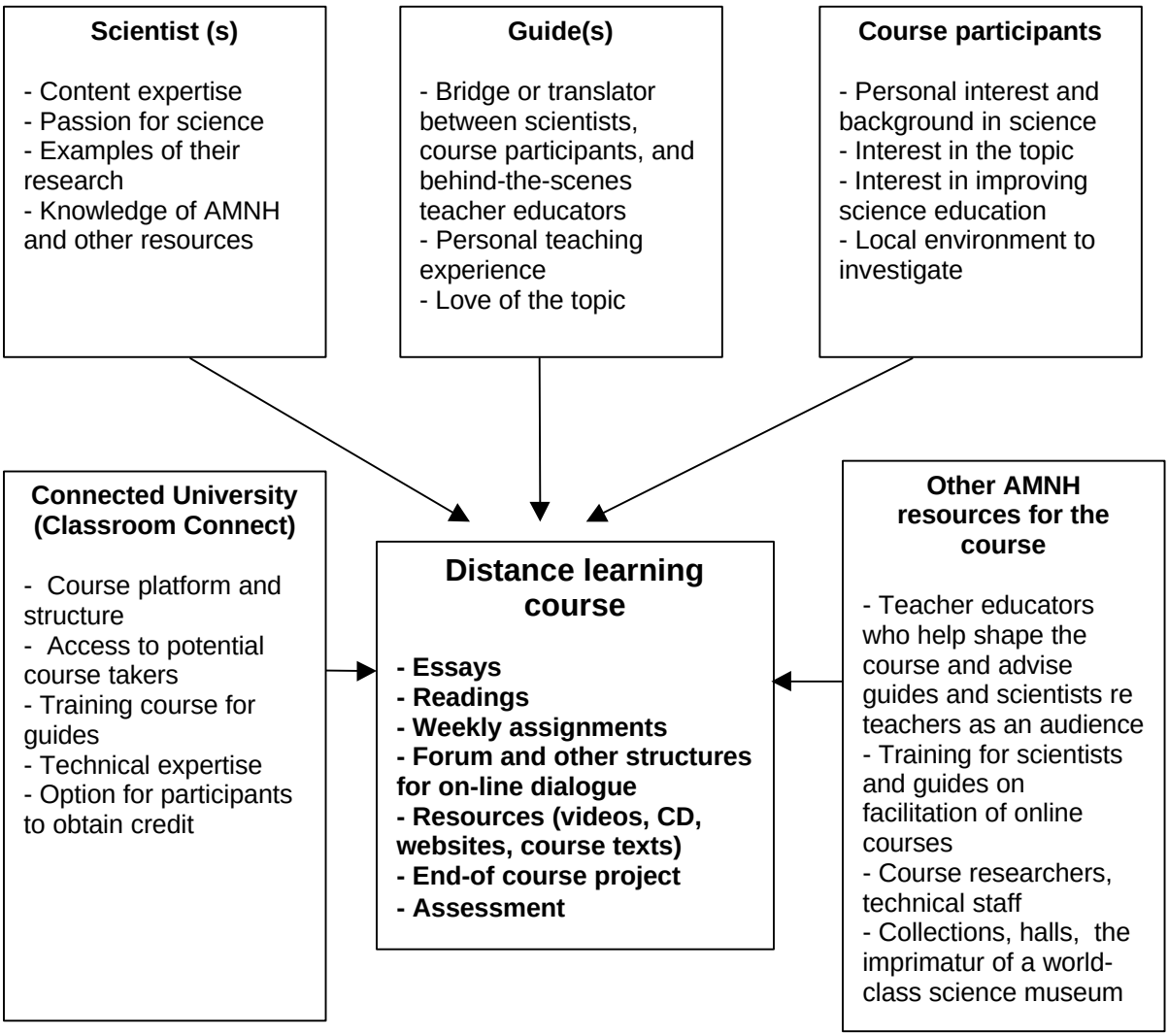
- There are trade-offs involved in the decision whether to create an internal technical platform for a course or build onto that of an existing company. SOS's informed decision to work with Connected University appears to have led to a fruitful partnership.

- Scientists enjoy teaching on line, experiencing many rewards and very few constraints.

- Through careful documentation and training, the program has made it possible for scientists and guides to lead the courses at a distance from the AMNH and one another. Participants can thus benefit from the input of scientists in the field, as well as from the guidance of handpicked guides from around the U.S.

The following diagram displays the basic structure of the course model:

Figure 1.
The SOS course model



Like developers of any new model, AMNH staff have encountered numerous challenges. They have been able to address many of them because the deliberate process of gathering feedback brought issues to the surface, and the staff has been attuned to quality and improvement. Some challenges persist. Course development costs are higher than for a conventional course because of the collaborative and intensive creation process. While courses are in session, they can take considerable time per student to lead. Because the courses are grounded in the real experiences of scientists, offering a new course entails recruiting, preparing, and supporting one or several new scientists to lead it; since scientists move on to new work, the project needs continually to find and train non-authoring scientists to assume leadership. Similarly, recruitment, training, and support of the all-important guides is an ongoing need. These challenges may well be inherent to the distinctive SOS model and to the nature of on-line teaching; thus, they may have implications for the next phase of work as well, particularly the challenges in dealing with issues of scale.

III. CONTRIBUTIONS OF THE SOS COURSES TO TEACHER KNOWLEDGE AND CLASSROOM PRACTICE

Characteristics of educators taking SOS courses

- The typical course participant is an established veteran teacher with an existing interest in science and the initiative to seek out personal learning opportunities.

- Nearly 80% are teachers at grades K-12. Of those, 45% teach high school, 33% teach middle school, and 21% teach elementary.

SOS courses seem to provide resources and opportunity to learn for those teachers who are motivated to spend 4-6 hours per week on the courses, are personally interested in science, are perhaps professionally isolated, and are willing to use personal initiative to learn for themselves.

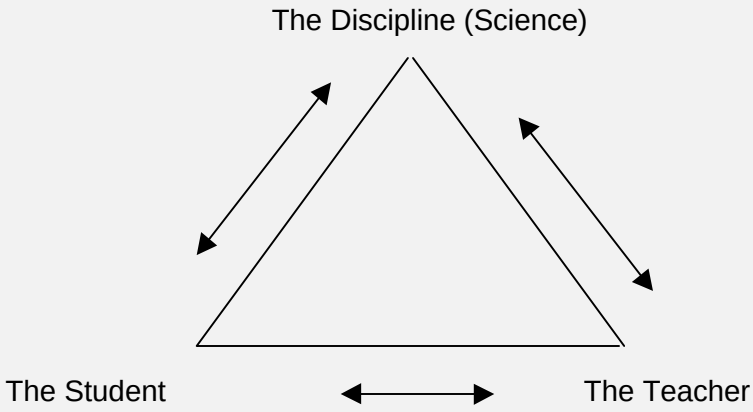
Contributions of the courses to teacher learning and classroom practice

To assess the value of the SOS courses for teachers, we used a conceptual model of a "relationship triangle" between the teacher, the student, and the subject discipline. The model is intended to show the following dynamics at work:

- when a teacher has a strong and meaningful relationship with the subject discipline (*the two-way arrow on the right*), and
- when the teacher has a strong and meaningful relationship with his/her students (*the two-way arrow on the bottom*), then

- the teacher can achieve the learning goal, which is to create a strong and meaningful relationship between the students and the subject discipline (*the two-way arrow on the left*).

Figure 2.
The Relationship Triangle for High-quality Instruction



Through learner surveys and interviews, we examined the extent to which, and the ways in which, the SOS courses strengthened each leg of the triangle.

- **Teachers tell us that the SOS courses strengthen their personal relationship with the discipline** by adding to their own personal knowledge of the subject (91% of survey respondents), providing resources they can draw on for their own learning (83%), giving them deeper insight into the work of scientists (76%), rekindling their passion for science (74%), and motivating them to continue learning science (67%).

One scientist leading a course said this:

> I have taught geology to elementary teachers before, so my expectations of the students were not high, to say the least. But in general they surprised me by their motivation, desire to learn, and amount of material they seem to have picked up.

- **The SOS courses enable teachers to bring more to their instructional relationship with students**, including new content (72%), new teaching materials and resources (77%), and new kinds of learning activities that were

modeled in the courses (73%). Some teachers (45%) also say that student confidence in their teaching has increased.

- **Though the courses are aimed at adult learning, the teachers are using course resources to connect their students to the discipline** by, for example, creating new lessons or units of study (71%), making course resources available directly to their students (60%), and involving their students in some of the course activities (48%).

- **Over half of the teachers think that their participation in the courses strengthens their students' relationship to science** by, for example, increasing students' appreciation for the natural world (58%), piquing their curiosity about course topics (52%), and increasing their understanding of the work of scientists (52%) and of scientific inquiry (49%).

- **Teachers find SOS courses to be more valuable than other learning opportunities available to them**—better than typical professional development (83%) and better than other on-line courses (79%).

Snapshots of learner experience:

> One **5th/6th grade teacher** took two courses, Universe and Genetics, because they "fit so well with what I wanted to do in class with my students. I felt it would give me the background to do some new things in class, to get information from experts and to learn about resources I could use in class." The teacher used the courses as background and as a knowledge base for her teaching; implemented the lesson plans she had done for course projects; created online activities for her students; and utilized the course CDs as resources in her classroom.
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> One **high school teacher** in a rural state took five courses. She was inspired to write grants for special classroom projects. One grant, inspired by the Fishes course, was for an aqua-culture project for her students and a group of special education students. "We [in this region] are number one in the country for heart disease. I wanted kids to know that aqua-culture here is big, and to learn about heart-healthy seafood dishes. We ended up being able to buy water testing kits and catfish products, produced locally, and the students made heart-healthy lunches. It was new to them, because around here we have old-fashioned cooking. Also, our kids got to understand those special education kids better, as well as some of the science about fishes." The AMNH courses also helped prompt and prepare her for seeking and obtaining National Board certification. "Having taken these courses helped me, two years ago, on my National Board application, and I got

> [certified]! The courses helped pique my interest in learning new things again and trying new things like trying for the national board certification."

IV. THE SOS PROJECT AS A MODEL OF EDUCATIONAL ENGINEERING FOR INNOVATION

We believe that the considerable contributions that the SOS is making at the intersection of professional development, online learning, and the role of science-rich institutions—along with its direct contributions to participants—are due in some large part to the AMNH's process of course development and prototyping. We conclude the report by reflecting on how the AMNH SOS project has taken an "educational engineering" approach, with the hope that others may learn from their experience.

An engineering approach allows for an iterative process of testing and revision. Each of the following steps allows the product to evolve as well as contributes to cumulative knowledge of the product's overall value and effectiveness:

1. Identifying and clarifying the design problem to be solved or the challenge to be addressed
2. Examining current theory and current practice
3. Inventing design conceptions
4. Establishing proof of concept
5. Assembling and testing prototypes, often through many iterations
6. Beta testing and scaling up
7. Large scale marketing, dissemination
8. Ongoing refinement

In the first year and a half, the SOS project created a vision for the courses that recognized needs in education; amassed relevant knowledge in the form of new working groups at the Museum, experts in the field, and literature; and laid out on paper a design for a new type of course. The first prototype courses were then offered in Spring 2000; they were reviewed intensively, and established the proof of concept. The first courses were revised substantially, and have been offered repeatedly, with each subsequent round of courses generating further refinements in quality as well as in course production and operation processes.

With the lessons learned from these first steps, the SOS project is well prepared to enter a new phase of beta testing, in which the refined courses will be offered in a range of different educational environments and conditions.

V. TOWARD THE NEXT PHASE OF DEVELOPMENT

We might regard Phase I as having succeeded in showing the "internal validity" of the course model, i.e., by showing that the SOS courses can indeed create both rich and practical learning experiences for teachers. Following on this success, the AMNH now faces an equally challenging task—to begin to show the "external validity" of the model. This is the next step toward a more systemic contribution to science education.

The project will demonstrate external validity when it has established approaches for helping others use the SOS courses and materials; when the courses and materials serve multiple educator audiences effectively; and when the courses can function—politically and educationally—in a range of settings. Such settings might include university teacher education programs, school district professional development programs, and/or school-university partnerships for science education.

We thus see the project as having the following goal for Phase II: to learn how to conduct new experiments in which the SOS model is adapted and tested in a few well-chosen and carefully engineered pilot settings. Lessons from this phase will lead to strategies in Phase III for scaling up the courses so they reach a broad, national market.