SPORE* SERIES WINNER

Bringing the Museum into the Classroom

Digital modules for online resources and good metadata help teachers find the museum's rich, authoritative science content to use in their classrooms.

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Field trips to science institutions offer an opportunity for teachers to spark student interest and to supplement their classroom teaching with vivid experiences of science and nature. At the American Museum of Natural History (AMNH) in New York City, education is central to our mission, and all content is developed to support learning. Museum exhibition and education staff produce media-rich content that is scientifically authoritative, thanks to collaboration with members of the museum's research staff of more than 200 active scientists. Digital technology opens new avenues to bring these resources into the classroom to extend a class field trip or to bring the museum to classrooms outside the New York City region.

Research shows that when science teaching engages students in authentic scientific inquiry, it improves their understanding of both content and process (*1*, *2*). Effective science teachers supplement their curricula with stimulating scientific content resources that inspire students' personal connection (see the first figure). When teachers bring museum resources into the classroom, students' engagement in the content and the practices of science increases (*3*). Supplements help teachers adapt their teaching to students' cultures, interests, and capabilities, which vary from district to district and classroom to classroom (*4*, *5*). These factors inspired Resources for Learning (RFL), a free, online catalog of the AMNH's science education materials (*6*).

We designed RFL to make the museum's science content accessible to all teachers. This includes subject matter derived from the museum's permanent exhibitions, as well as a growing body of materials produced directly for online use and dissemination. In addition, AMNH produces several new special exhibitions every year. All exhibitions have an online presence accessible through RFL.

About 10 years ago, AMNH began to produce science content specifically for an online audience. The museum's Science Bulletins program produces short video documentaries and visualizations for display in our permanent exhibition halls, for distribution to 30 institutional subscribers around the world, and for free distribution on the Web. Science Bulletins stories report on current scientific research in astrophysics, Earth sciences, biodiversity, and evolution. OLogy, the museum's Web site for kids, is updated with each new exhibition and contains hundreds of articles, activities, animations, and interactive programs that engage kids in the subject matter, concepts, and practice of science. OLogy content is created directly for online use and is based on the concepts and learning goals of the exhibition. As is true for our exhibitions, all materials produced for online audiences benefit from the direct involvement of museum scientists, who carefully author, edit, and review the content.

AMNH content is cataloged for teachers. Teachers use Resources for Learning to discover engaging, authoritative current science content like this Science Bulletins video to supplement their science curriculum and to engage students' attention and interest.

Through formative evaluation, including focus groups with classroom teachers, we learned that descriptive metadata, such as grade level, resource type, and amount of class time required would help teachers find and evaluate useful resources. Formal usability testing of a beta version of the RFL site, launched in Spring 2002, led to the development of a search function that enables targeted searches via a catalog organized by scientific disciplines and subtopics. "Teacher Tips," written by staff science educators with classroom experience, offer advice on how best to adapt exhibition materials, science video documentaries, and other types of resources for use in the classroom. Correlations with the National Science Education Standards (*7*) help teachers connect resources to specific goals and requirements.

Teachers told us that, when looking for ways to supplement their curriculum, flexible content modules were easier to integrate into their existing practice. Thus, RFL favors smaller, stand-alone modules over complex, multipart items. As we add materials, we partition them into their smallest self-contained components, each with its own cataloging metadata. This increases "surface area," affording each item more opportunities to match a particular user's requirements. RFL content modules can be used individually or combined with other resources to make up a 1-day lesson plan, a multiday unit, or even a semester-long curriculum.

These fine-grained, cataloged, and cross-referenced content modules facilitate the reuse of items in new contexts. For example, for each of the special exhibitions offered at AMNH, we create a "special collection" of existing resources that support and extend its major themes. A recent exhibition on climate change included videos on tropical glaciers in Peru and boreal forests in Alaska, as well as visualizations of global sea surface temperature, all of which had been previously produced for Science Bulletins and cataloged in RFL. In addition, the full content of each exhibition-specific Educator Guide is housed in RFL, with each of the learning activities cataloged individually to make them available for new uses in the classroom.

Teachers report using RFL to locate specific resources and to design meaningful learning experiences for their students. A high-school teacher who was developing a microbiology course wanted to find resources on evolution and biodiversity. He told us, "It is inconceivable for me to plan a curriculum for a microbiology course without exploring

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*SPORE, *Science* Prize for Online Resources in Education; www.sciencemag.org/special/spore/.

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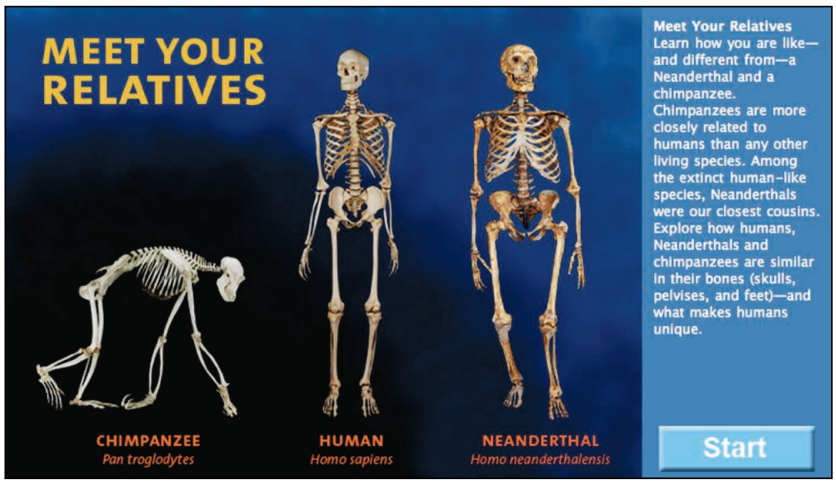
Published by AAAS

genomic research, biotechnology techniques, and the driving force of biodiversity: evolution." Using resources he found through RFL, he took his students on a "virtual tour" of the museum's human origins exhibition, where students learned how to evaluate fossil evidence and how it applied to the science of understanding hominid evolution (see the second figure). He also incorporated two interactive "tree of life" resources from OLogy to demonstrate how scientists use cladograms to model evolution. Another teacher sought to engage her fifth graders in a unit on biological communities by letting them explore some biodiversity activities on OLogy, which inspired her students to ask questions such as "how are humans connected to bacteria and insects?" Questions like these support the assertion that supplementary resources inspire and support authentic student inquiry.



Exhibitions extend to the Web. Content developed for exhibition halls—such as this interactive comparison of chimpanzee, Neanderthal, and human skeletons—is adapted for Web access and cataloged in Resources for Learning.

Across the board, teachers report that they value access to this curated database. "This AMNH [Web site] is a great tool to use in the classroom for students to gain a better understanding of a complex concept," commented a middle-school teacher in New Jersey. "The resources of the AMNH seem endless, with unlimited virtual access," said a teacher from a New York City high school. They have also indicated an interest in accessing lessons that connect to these resources and that have been implemented in classrooms by their colleagues. This information is influencing the museum's digital content strategy, which aims to provide teachers tools (such as a new lesson-planning tool for selecting and organizing online resources) for use in their classrooms and to share with other teachers.

Our content model enabled a partnership with Macmillan McGraw-Hill, which publishes kindergarten to sixth grade (K–6) science textbooks used in classrooms nationwide. We used RFL to create special collections of AMNH resources correlated to the key topics and learning goals of each chapter in the textbook series, offering teachers around the country additional ways to connect the textbook material to the interests of students in their classroom. Our model has also fostered new partnerships by making it easy to share with and contribute to similar repositories, such as National Science Digital Library (NSDL), Digital Library for Earth System Education (DLESE), and Science and Math Informal Educators pathway (SMILE).

Demonstrating the value of modular content and robust metadata are another way that RFL continues to inform the museum's overall digital content strategy. The museum recently launched a new mobile application, the AMNH Explorer, which helps visitors on site in the museum find their way through exhibition halls and allows them to bookmark exhibition objects for further exploration online. Our education department is working with local teachers to consider how the next version of Explorer might enhance their teaching at the museum and in the classroom. These teachers express a clear desire to be active users of the device, to plan field trips around the topics they are teaching, and to incorporate related content, like Science Bulletins, into their plans. The museum is also redesigning its Web site with a new strategy that will represent both exhibition-based and created digital files as reusable, modular content with thorough metadata, so that the new capabilities these teachers ask for can be developed on any digital platform.

The future of science museums embraces both kinds of experiences: the irreplaceable impact of directly encountering physical evidence on site, and the ready access to an enormous library of authentic scientific content by means of many digital platforms. The goal is a continuous presence for the museum's content that extends into the classroom as a ready resource for effective science teaching.

About the authors

Steve Gano is director for education in the American Museum of Natural History's Digital Media department. He was the information architect and technical director for the museum's educational Web sites, including Resources for Learning.

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8. The development of Resources for Learning was made possible by a grant from The Louis Calder Foundation. The National Aeronautics and Space Administration provided significant educational and programming support.

10.1126/science.1197076