Exemplary Science in Informal Education Settings

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Standards-Based Success Stories

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Using the National Science Education Standards for Improving Science Education in Nonschool Settings

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University of Iowa

The Exemplary Science Program (ESP) series has become a featured activity in terms of publications and conference features for the National Science Teachers Association. This fifth volume is the first that has departed from a focus on formal education with specific ties to teaching levels in schools and the professional development of classroom teachers and the visions for them included in the National Science Education Standards (NSES). Although attention to professional development was undertaken almost as a last-minute addition to the 262-page first draft of the NSES, it was the topic of the first ESP monograph that was completed and the one attracting the most interest in terms of chapter authors and use of the changes envisioned. This, no doubt, is the result of college and university faculty being more familiar with publications and their requirement for promotion and tenure. The Professional Development monograph's popularity may also relate to the importance of staff development for teachers and others vitally concerned that our teaching efforts be more related to real learning, i.e., learning with understanding—learning that results in something other than remembering what one is told, instructed to do, or asked to repeat as evidence of learning (none of which indicate real learning let alone its being "exemplary!")

This work in the Informal Science Education arena has been possible because of the interest and support of the Association of Science-Technology Centers (ASTC). It expands the opportunities for real learning because it is not restricted to a place and building called "school"—a 180-day exposure each year, six-hour days, where science is a focus for a single class period.

The excitement is that the NSES focus upon nine ways teaching must change if more learning on the part of students is to be achieved. Many now argue that the nine *More Emphasis* conditions outlined in the NSES represent the primary needs for educators (including parents) if learning is to be enhanced. Further, the 14 ways that staff-development efforts must change (teaching teachers) provide further indications of what is needed in terms of experiences for teachers (both in formal and informal settings), if real learning is to occur. This means learning that relates to the science enterprise itself, affecting daily lives, enabling persons to make informed citizenship decisions, and improving economic productivity by using the information and skills in related careers. These are all important goals that frame the NSES (p. 13).

The National Advisory Board (NAB) for the ESP, whose efforts resulted in the first four monographs, recommended to NSTA Press and the Executive Committee that the ESP efforts be continued—with varying NAB membership to coincide with given foci for nominating exemplars. Although several areas were proposed for the 2007 effort, the one that emerged as top choice was Informal Science Education. It resulted in this new publication that has been nurtured and directed by the 2007 NAB, which includes several ASTC leaders to supplement the NSTA leadership. This new group of 21 NAB members who worked diligently on this fifth ESP Monograph are acknowledged and listed (see p. xvii).

In addition to the NSES, the NSTA official Position Statement on Informal Science Education guided the work, as did the involvement and advice provided by the NSTA Committee on Informal Science. The NSTA leadership also urged the involvement of ASTC in interpreting and elaborating the criteria, attracting needed nominations, and assisting with analyzing the extensive information included in the nominations. But the visions for improved science education were all included in the NSES, where lists of *Less* and *More Emphases* conclude each chapter. These were distributed widely as "the" criteria for ESP. As with the other ESP Monographs, these *Less/More Emphasis* summaries are included in Appendix 1 (p. 252).

History of the National Science Education Standards

Before discussing the content of this book at greater length, a brief history is offered of how the National Science Education Standards came to be. Most educators credit the National Council of Teachers of Mathematics (NCTM) with initiating the many efforts to produce national standards for programs in American schools. In 1986 (10 years before the publication of the NSES), the board of directors of NCTM established a Commission on Standards for School Mathematics, with the aim of improving the quality of school mathematics. An initial draft of these standards was released in the summer of 1987, revised during the summer of 1988 after much discussion among NCTM members, and finally published as the *Curriculum and Evaluation Standards for School Mathematics* in 1989.

The NCTM standards did much for mathematics education by providing a consensus for what mathematics should be. The National Science Foundation (NSF) and other funding groups had not been involved in developing the math standards, but these groups quickly funded research and training to move schools and teachers in the direction outlined in those standards. Having such a "national" statement regarding needed reforms resulted in funding from private and government foundations to produce school standards in other disciplines, including science.

NSF encouraged the science education community to develop standards modeled after the NCTM document (1989). Interestingly, both the American Association for the Advancement of Science (AAAS) and the National Science Teachers Association (NSTA) expressed interest in preparing science standards. Both organizations indicated that they each had made a significant start on such national standards—AAAS with its *Project 2061* (1989) and NSTA with its *Scope, Sequence, and Coordination* project (1992). Both of these national projects had support from NSF, private foundations, and industries. The compromise on this "competition" between AAAS and NSTA leaders led to the recommendation that the National Research Council (NRC) of the National Academy of Science be funded to develop the National Science Education Standards. With NSF funding provided in 1992, both NSTA and AAAS helped to select the science leaders who would prepare the NSES. Several early drafts were circulated among hundreds of people with invitations to comment, suggest, debate, and assist with a consensus document. A full-time director of consensus provided leadership and assistance as final drafts were assembled. Eventually, it took $7 million and four years of debate to produce the 262-page NSES publication in 1996.

There was never any intention that the Standards would indicate minimum competencies that would be required of all. Instead, the focus was on visions of how teaching, assessment, and content should be changed. Early on, programs and systems were added as follow-ups to teaching, assessment, and content. And, as mentioned earlier, Staff Development Programs were added just prior to final publication.

The NSES goals were meant to frame the teaching, staff development, assessment, content, program, and system efforts as visions for change and reform. These goals represented a step beyond those central to Harms' earlier Project Synthesis in 1978. The major difference was with the first goal. For Project Synthesis it was science for preparing for further study of science. (Unfortunately, that was the goal used by over 95% of the teachers and schools for justifying school science.) Instead of academic preparation, the NSES included a goal that focused upon the actual practice of science. It was considered the most important goal of all and one on which the most time and energy would be spent! The four goals (justifications) for K–12 science listed in the NSES encompass preparing students who:

(1) experience the richness and excitement of knowing about and understanding the natural world;
(2) use appropriate scientific processes and principles in making personal decisions;
(3) engage intelligently in public discourse and debate about matters of scientific and technological concern; and
(4) increase their economic productivity through the use of the knowledge, understanding, and skills of the scientifically literate person in their careers (NRC 1996, p. 13).

Basically, the goals do not suggest any content or any glamorized process skills that must be transmitted or experienced for their own sake. Paul Brandwein (1983) frequently called for teachers and schools to ensure that each high school graduate would have one full experience with science. He suggested that this would create a revolution in science education—something we still badly need. Some NSES enthusiasts suggest that one such experience each year would be a better goal during the K–12 years—a 13-year continuum of science in school—and perhaps one each 9-week grading period would be an even better goal!

The NSES volume begins with standards for improved teaching. This is followed by chapters on professional development, assessment, science content, and science education program and systems. Content was placed in the document after the other three for fear that placing it first would invite a focus only on what should be taught—almost relegating teaching, staff development, and assessment to "add-on" roles. Nonetheless, the major debates in the development of the Standards centered on what should appear in the three discipline-oriented content chapters.

NSES "Content"

A major direction in the NSES with respect to content was the identification of eight facets of content. These facets change the focus from a traditional discipline focus with a list of major concepts under each discipline, to a much broader listing that is more indicative of the goals (justifications) for science in schools. These eight facets of content elaborated in NSES are (1) Unifying Concepts and Processes in Practice; (2) Science as Inquiry; (3) Physical Science; (4) Life Science; (5) Earth and Space Science; (6) Science and Technology; (7) Science in Personal and Social Perspectives; and (8) History and Nature of Science. Just as the first NSES goal is considered the most important one, the first facet of content (Unifying Concepts and Processes in Practice) is similarly considered the most important. It was envisioned as being so basic that it was first thought to be included as the preamble for each content section of NSES. However, many felt that too many would simply move to a new listing of basic discipline-bound concepts and ignore the preamble. Although life, physical, and Earth/space science still appear, some lists combine them into a listing of basic science concepts as a single content focus—thereby suggesting a more integrated approach to the major concepts comprising modern science. Major debates occurred in identifying these eight content constructs and the specific content included in each of the "discipline-bound" content areas.

Important current reforms must focus on the four less familiar content facets, namely: (a) science for meeting personal and societal challenges (referring to goals 2 and 3); (b) technology—which now enjoys a whole set of standards produced by International Technology Education Association (ITEA 2000); (c) the history and philosophy of science; and (d) science as inquiry.

The *More Emphasis* conditions for inquiry represent what the current reforms are all about and indicate why the use of social issues is considered essential. The *More Emphasis* conditions for inquiry are meant to reverse the failures in 1981 in finding examples of teaching science by inquiry in American schools. After the Project Synthesis report, Paul DeHart Hurd (1978) reported:

> "The development of inquiry skills as a major goal of instruction in science appears to have had only a minimal effect on secondary school teaching. The rhetoric about inquiry and process teaching greatly exceeds both the research on the subject and the classroom practice. The validity of the inquiry goal itself could provide from more scholarly interchange and confrontation even if it is simply to recognize that science is not totally confined to logical processes and data-gathering" (p. 62).

Issues related to student lives, their schools, and their communities can provide the contexts that invariably require the knowledge of skills related to the concepts and skills that appear in science programs in typical schools. The Informal Science Education community can (and should) take the lead in changing the focus for science learning and the introduction of new contexts for ensuring learning with understanding.

Features of Real Science

Most science courses in school are devoid of any of the features that characterize real science. These include the following features, each important and in a fixed order: (1) curiosity abut the objects and events encountered in the natural world; (2) offering possible explanations for them; (3) collecting evidence to establish the validity of the personally advanced explanations; (4) communicating the explanations for which evidence has been collected; (5) responding to criticisms and counter-explanations from others, including scientists.

Most science courses in K–12 schools no longer focus on technology since the 1960 reforms, which boldly proclaimed that science for schools should exemplify pure science (i.e., information concerning what is known by scientists about the natural world) and not the human-made world. Reform efforts now openly include the design-world and further see it to be a way of studying the natural world in terms of better instrumentation as well as a meaningful way of using the same processes to gain new standards constructed for human betterment. The techniques characterizing technology are like those of science. The major difference is that the answers to real questions about the natural world have no initial answers (scientists start with the unknown!). In the case of technology, the persons involved know from the start what answers they hope and plan to attain. Current efforts in science education often give equal (or even primary) emphasis to the design world over the natural world. This is a real strength for the science encountered in informal settings—for it is not bound to textbooks, state curricula, or a focus on mastery of basic concepts.

Questions are basic to science. They provide the focus for all science efforts. But, it is rare for science in formal settings to focus on questions. Similarly, in schools, student questions rarely serve as starting points in classrooms. Ideally, learning is enhanced if student questions are "higher-level ones." Questions offered by learners and/or educators in informal settings should focus on the following types of questions:

(1) Questions that ask others for information such as: What did you do? What happened? What did you observe?
(2) Questions that ask: What will you do next? What will happen if you…? What could you do to prevent that?
(3) Questions that relate to situations with others: How does that compare to…? What did other people find?
(4) Questions that seek explanations: How would you explain that? What caused it to happen?
(5) Questions that ask for advice: What evidence do you have for that? What leads you to believe that?

Attracting Nominations

After publicizing the plans for this ESP monograph among members of the NSTA Informal Committee and the total ASTC membership, and encouragement from the NAB team formulated for this new monograph, over 60 nominations emerged. All received word of the nomination and information regarding the plan for the monograph and a general structure for what would comprise a chapter. All were asked to submit a content outline that would include:

(1) nature of the informal organization;
(2) an indication of importance of the NSES visions on their programs;
(3) outline of a proposed chapter;
(4) indication of program features; and
(5) information concerning assessments of program impact.

All of the plans and initial information concerning programs were read and evaluated by five members of the NAB. These evaluations were forwarded to each proposed author team. Semifinal drafts were then requested. A total of 36 were received and again evaluated by members of the NAB. Summaries of comments from the NAB reviewers were forwarded to all authors; all were encouraged to consider the recommendations and to prepare final drafts for final decisions about which would be included as monograph chapters. The 17 chapters comprising this volume represent those judged best to illustrate successful features of the NSES that resulted in most learning on the part of those who were targeted groups, i.e., participants in the informal settings.

Conclusions

The 17 chapters that follow provide the cooperative endeavors of the authors indicated as well as the involvement of at least four members of our NAB. Certainly the expertise of my coeditor John Falk was of utmost importance in assembling the exciting program described. Informal science education has been his focus for his entire professional life. I am in his debt for being continually involved. Of most significance is the assessment data that are included in each chapter, especially the goal that real evidence of learning would comprise at least a third of each chapter. This was certainly the most difficult aspect for many authors. Many pleaded for the opportunity to provide assessment data on a continuing basis. Several initially offered only a plan for assessing impact.

It has been our intent to make science education more of a science—where all the ingredients that define science are involved. This means starting with not knowing, but moving to and modeling "how to know." We offer the evidence for success included in each chapter as evidence that our efforts in the informal arena are like science itself—starting with a question, having ideas as possible answers, collecting evidence from as many sources as possible to validate the answers suggested, and communicating the results (something we hope this volume illustrates) for others to use, possibly to formulate new questions.

We feel that our successes with the visions that guide the NSES will be greater with the union of the formal and informal providers for the learning of all people. We feel that science literacy for all will be a reality when there is a seamless connection between formal and informal education and life. These are facts one emphasized with a quote from Stephanie Pace Marshall (IMSA):

"To educate our children wisely requires that we create generative learning communities, by design. Such learning communities have their roots in meaning, not memory; engagement, not transmission; inquiry, not compliance; exploration, not acquisition; personalization, not uniformity; interdependence, not individualism; collaboration, not competition; and trust, not fear."

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John H. Falk has spent more than 30 years investigating and supporting free-choice learning. He is considered one of the world's leading authorities on learning in informal settings such as museums, science centers, zoos, and aquariums. He is currently Sea Grant Professor of Free-Choice Learning at Oregon State University; he is also founder and President Emeritus of the Institute for Learning Innovation, a world-renowned free-choice learning research and development center located in Annapolis, Maryland. Falk has published more than 100 scholarly articles and 17 books in this area. He earned bachelor's and master's degrees in zoology, and a joint doctorate in ecology and science education; all from the University of California, Berkeley.

Science With Attitude:

An Informal Science Education Experience

Dean Jernigan, Dana McMillan, Katherine Patterson-Paronto, and Elaine Ceule
Union Station Kansas City

A middle-American city in the middle of the United States, Kansas City is the epitome of America's heartland—a place where average "Joes" and "Janes" abound. Its reputation for normalcy is such that it has long been a testing ground for consumer attitudes about new products and services.

The metropolitan area's population of more than 1.7 million is more diverse than some would expect, breaking down as follows: 80.80% White, 12.80% Black, 5.2% Hispanic, 1.6% Asian and 0.50% Native American. Public school districts in the area include some of the nation's highest ranked as well as some of its worst.

Union Station in 1917.


Grand Hall of Union Station.

There are actually two Kansas Cities—the larger is in Missouri while its much smaller cousin is in the state of Kansas. The state divisions end at Union Station, completed in 1914 as one of the nation's largest rail passenger terminals and reopened through a bi-state tax initiative in 1999 after years of decline and neglect.

Today, a fully restored Beaux-Arts masterpiece operated as a 501(c)(3) corporation, Union Station Kansas City (USKC) is home to a permanent rail exhibit with vintage rail cars (*KC Rail Experience*) and an interactive science center (*Science City*), as well as theaters, restaurants, shops, and meeting spaces. Today the station is once again a busy Amtrak stop.


Interior of Grand Hall.

Since its renovation, Union Station Kansas City often is referred to as the area's "Little Switzerland," or "Kansas City's front porch," bringing together a diverse and far-flung metropolitan population for civic, social, and community events.

Central to the mission of USKC is the presentation and interpretation of Kansas City's regional history and the promotion of science and technology (the latter has been identified as a high priority by the area's business and civic community). This is accomplished through the development of collections, exhibits, and educational programming.

It is in the spirit of USKC's role as the Kansas City area's connecting point that we developed the Science City Summer Camp program, "Science With Attitude." The attitude in this case is one of inclusiveness and diversity of purpose, methodology, and participation. This "attitude" is accomplished through the program's goals:

- Involve children ages 6–12 years from a wide range of socioeconomic backgrounds.
- Train and employ young adult teaching assistants, one-half or more of whom are from the area's urban core.
- Promote a cooperative teamwork approach among the staff, with special emphasis on

child development and pedagogy.

- Involve and combine science, technology, engineering, and math with other disciplines such as art and music in order to promote maximum participation and address diverse learning styles.

Science City Summer Camp Structure

The staff design of the successful science program requires many levels of leadership and encourages development of leadership skills with practical and engaging interactions with science and people.

The support staff of Informal Science Educators (ISE) begins with a *Director* whose responsibilities include liaison with community partners and local funders, and who also provides leadership and direction for the overall function of the program. A *Child Development Specialist* (CDS) works with all child participants and staff personnel in the program. The CDS is especially helpful with interviewing, training, and transitioning students selected from community organizations into leadership roles within the program. An ongoing function of the CDS is to maintain the integrity of the program, intervening as necessary to keep the emphasis on best practices.

The *Camp Manager* also assists with hiring and training staff, but primarily plays a supervisory role in the daily function of the program.

The *Registrar* organizes the enrollment procedures, responds to parent inquiries and performs much of the recordkeeping throughout the planning and implementation of the summer program.

The *Instructional Team* of ISEs consists of licensed teachers who develop and facilitate the activities in the five subject matter–specific learning centers. These centers are:

- Investigative Science (Life Science emphasis)
- Investigative Science (Physical Science emphasis)
- Active Expression (Writing, Drama, Music emphasis)
- Creative Arts (Visual Arts emphasis)
- Science City (Science Center programs)

Each center has a dedicated space and equipment. Each lead teacher receives $18 an hour for development and instructional expertise, and is responsible for managing the use of $2,000 for instructional supplies throughout the program.

Teaching Assistants (TAs) support the centers' learning activities and model behavior for the younger students. Twenty TAs were hired to assure each camper could participate in small group activities—each with its own leader. Ten of the TAs are *specialists,* providing support for the lead teacher and performing specific responsibilities within the center as each group visits that activity. Ten additional TAs are *generalists* who lead their small group through the rotation of centers and encourage small group interaction and enjoyment of the day in general.

The TAs may be given the opportunity to switch roles from generalist to specialist, or specialist to generalist, during the course of the summer.

Half of the TAs were selected from those recommended for interviews by our community partners. The other half were selected by interviewing high school and college students who independently sought summer employment, and indicated an interest in science and education. All TAs receive $8 an hour in wages. For many of these young people, it is their first job.

The eight-week summer program features four weekly themes that repeat after the first four weeks. Weekly themes for 2006 were:

- Fur, Feathers, and Scales (nature theme)
- Concoctions, Cooking, and Reactions (chemistry theme)
- Stars, Planets, and Astronauts (space exploration theme)
- Dinosaurs to Terror Cranes (the ancient world)

In 2007 the themes will change to:

- Fur, Feathers, and Scales (nature theme, including the ancient world activities)
- Concoctions, Cooking, and Reactions (chemistry theme)
- *New!* Catapults, Bridges, and Robots (design and build theme)
- Stars, Planets, and Astronauts (space exploration theme)

Science City.

A Day at Science City Summer Camp

Children are greeted by a samba band each morning as they arrive at the program. The band is a participatory and welcoming activity that sets the mood for an active daily program. Five brightly colored flags provide visual assistance in grouping the children into the five age-level groups. At the morning samba band performance, each of the five groups is accompanied by two TA generalists who remain their group leaders throughout the week's activities. Science experiences take on a whole new dimension for the 750 children, ages 6–12, enrolled in this one-of-a-kind summer camp with regular programming from 9 a.m.–4 p.m., and optional early/late care 7:30 a.m.–6:00 p.m.

Drawing on the knowledge that people have different learning styles, Science City introduces science concepts each day of the eight-week camp through creative art projects, active expression (dance, music and drama), active play, or investigation. Students have a true "camp" experience, but learn about science in ways not typically available even in their school classrooms. Perhaps the best way to showcase Science City Summer Camp is through the eyes of one of the participants and the dedicated people who made this camp a reality. Let's follow Maddie as she grows and learns throughout the 2006 summer program.

Meet Maddie

Maddie is a nine-year-old girl whose mother enrolled her in Science City Summer Camp because Science City at Union Station is near her place of employment. She would be able to drive Maddie to camp each morning and pick her up after work. She felt secure that Maddie would be near her during the day and even allow her to occasionally have lunch with her. Maddie's mother also has concerns that her daughter's science education may be lacking. Like many younger elementary school students, Maddie has had limited science instruction. With the emphasis on reading and math and the high-stakes testing that have become too familiar under the federal mandates of No Child Left Behind, Maddie's suburban elementary school is able to provide very little time for a science curriculum. Just as in many other neighborhood schools, the science instruction is provided by an elementary school teacher who may lack skills and resources to offer much more than basic science facts without hands-on applications. Typically, children like Maddie receive science instruction about 30 minutes per day for three to four days per week. In some cases, the science instruction is shortened due to rotation with social studies classes.


Samba band greets children.

But Maddie likes science. She has been on school field trips to the zoo and visited an aquarium with her family. She is curious about dinosaurs and asks her parents difficult questions about how things work. She enjoys working in the garden with her grandfather and loves to search for insects when she plays outside. But this nine-year-old suburban dweller has likely never considered a career in science. Her stereotype of a scientist is an old man in a white coat doing something mysterious with funny looking tubes. Additionally, Maddie has spent very limited time with children outside her neighborhood; she has never explored a vast space like Union Station in midtown Kansas City, nor had opportunities to pack her days being challenged to think beyond standard rote questions. All of that is about to change.

When Maddie arrives on the first day of Fur, Feathers, and Scales week, she is feeling a little overwhelmed. Standing just outside the entrance to Science City at Union Station she is greeted by a large number of adults in matching polo shirts playing an amazing collection of drums and other unusual instruments. The Samba band opens Maddie's senses to an electric beat as it fills the large space. Other children are arriving. Some come with their parents, just as Maddie has with her mother, but others are arriving on a large school bus.

Maddie is provided a nametag with a color dot. She is told to join a group standing with several teenagers and a flag of the same color. All of the other children in the pink group look to be about her age but she does not know any of them. For a moment, Maddie has a feeling of fear and shyness. She looks to her mother for reassurance and when she has received it, she takes the plunge, kisses her mother goodbye, and joins the group.

Quickly, a teenager introduces himself as her "TA" (Teacher's Assistant) Dane. Dane is a high school senior. He joined the staff at Science City Summer Camp for a fun summer job. He has worked other summer jobs with children at the swimming pool and in recreational camps, but this is his first job that includes the responsibilities and challenges to make each child's day an amazing success. Dane realizes he must quickly find the skills for being leader. Maddie may not believe it but Dane is at least as nervous as she is about how this first day of the first week of camp will go.

Dane has learned during the staff training days, prior to the opening of camp, that his priority is to shepherd his group of children throughout their day. He must navigate the vastness of Union Station, keep the group on schedule, and attend to their personal needs. Beyond that, he is expected to participate in each of their planned activities. He has received training on child development, diversity, inquiry-based instructional theory, and constructivist's behavioral practices.

Dane's partner Terah is also nervous. This is her first job. She is just 15 years old and sometimes looks and acts closer to Maddie's age. Terah competed with more than 30 other young people to receive a spot on the staff. She was selected because of her infectious personality. She is not all that happy with the required uniform nor the expectation to be at work at 8:00 a.m. This may cramp her usual sleeping routine, but Terah knows this job is important to more than just her. She has a plan that so far, she has shared with no one. As soon as she receives her summer wages, Terah will use her first-ever paycheck to make the family car payment. Her mother is in the hospital and may not get out for a long while. If Terah can make the payment, they will be able to keep their family's only transportation. But Terah is not thinking about all of that right now. She must concentrate on how to perform her job this first morning. She received the same training as Dane and the 25 other staff members, and now besides all that, she has learned she is trying to form a meaningful partnership with Dane. She takes his lead and introduces herself to Maddie too.

Children with instruments.

When the pink group is formed and the band has set aside their instruments, everyone begins the trek through Union Station to the fourth floor of the east wing where camp is headquartered. Maddie has been to Union Station before but somehow it looks different when she is following along with the 25 other eight and nine year olds. As she walks across the Grand Hall, this Kansas City icon appears bigger and brighter than she remembers. Her eyes and mind are suddenly open to seeing this place as more hers than she ever thought about it before.

Along the trip Dane and Terah explain to the children that they will be following a schedule that begins their week in the Investigation Center with Miss Betty. When they arrive, the children are immediately thrust into an in-depth exploration of animals. Miss Betty begins by asking the children to print on chart paper what they know about vertebrates and invertebrates. Along with Dane and Terah, two additional TAs have been assigned to help Miss Betty throughout the week with the small group projects. During the morning hours in the Investigation Center, Maddie and her new friends settle into activities such as dissecting an owl pellet, creating a food chain, and examining plankton from a pond under a microscope. With a midmorning snack, the children are getting to know each other and their TAs.

Teacher's Assistant leads small group.

Maddie's biggest fear that Science City Summer Camp would feel like school has been forgotten. She and her now best friends find they not only can talk in "class"—they are encouraged to! Dane stays with the small group to model his interest in their activities, ask probing questions, and actively listen to the girls as they express their opinions on the topic. They laugh, relax, and learn so much that by noon they can hardly believe its' time for lunch.

Lunchtime is held in a room along Sprint Festival Plaza (the former Union Station North Waiting Room). All five groups, 125 students in all, and half of the TAs, gather to eat their packed lunches. This is not a typical school lunchtime. Children eat and chat with other students and TAs who have learned a more effective form of supervision by interacting with the children informally, serving as both a role model and an interested friend. Maddie and her friends discuss the contents of their lunches, occasionally trade food, and make their best nine-year-old jokes about what owl pellets really are. After lunch they return to the fourth floor to play games in an area called "The Park" stocked with books on the topic of the week, puzzles, Legos, and bean-bag chairs to relax. Again, the

TAs play games and talk with them. TAs guide small groups of children to the Inquiry Wall to record the children's questions about the week's topic on animals.

After lunch, the Pink Group is scheduled with Miss Hallie in the Creative Expression Center. Quickly Maddie discovers a new aspect of science by exploring issues and attributes of animals through drama. As a practicing artist and director, Miss Hallie has developed interesting scenarios connected to the week's topic of animals. Using the simplest recycled materials such as scarves, yarn, and old boxes, she focuses the children using theater terms and a fully engaged student-centered approach. The children are divided into small groups, each assigned one TA. In her group, Maddie takes the role as the top carnivore in a living food chain. The afternoon flies by quickly culminating with each group performing their productions for the others.


Children perform.

By the end of the first week of Science City Summer Camp, Maddie has completed two rotations in each of the five centers. She has spent two sessions with Brad in Cooperative Games, another two with Trevor in Science City, two sessions with Kathleen in the Art Center, and returned to Investigations and Creative Expression. All the centers emphasized the science concepts chosen to match that week's theme. She has also made amazing friends she wants to keep in touch with beyond the summer. Most importantly for Maddie, her mother has signed her up for the remaining three weeks of this cycle of summer camp, convinced that Maddie is learning and growing beyond her highest expectations.

Dane and Terah have also learned much this week. Before the week is completed they have put into practice how to keep their charges engaged in each of the activities, keep everyone on schedule and learned to work together as a team. After several visits with Dana, the Learning Specialist, both Dane and Terah have been challenged in different ways. Dane had a meeting to talk about strategies for keeping the children involved during Cooperative Games without taking over the game for the children. Terah has been shown some "tough love" in conversations about remembering her responsibilities. During one of those discussions, Terah also shared with Dana her family situation. It was insightful for both of them. Weekly TA meetings, informal conversations with teachers, and bonding between TAs helps to keep everyone growing in their jobs. What was learned in the initial training days has become a reality for the entire staff as they face each day's challenges and rewards.


Child with flower pot.

The Scientific Attitude Prevails: The Challenge to meet Science Education Standards

Science City Summer Camp was developed as an innovative way to connect science with a child's world. The program planners incorporated hands-on, inquiry-based learning as the guiding principle in developing each summer camp activity. Campers would become aware that science is all around us. "Does it engage participants in investigation?" was the key question to be asked for each phase of the camp's development. What followed was programming that naturally fit the spirit and the letter of the changes recommended in the National Science Education Standards in the planning and implementation.

Students in creative expression class.

Teaching Standards

In preparation for the camp activities, the staff created the goals and learning objectives. Teachers were then given creative reign to develop themed lessons within that framework. Each teacher adhered to the ideals of interactive, small group-based learning activities in their planning. The children were to be considered active participants in their own science learning, and their natural inquiry and verbalized thoughts used as topics for scientific debate and discussion.

Students predict and discuss outcomes.

Revitalized Standards:

- Understanding and responding to individual student's interests, strengths, experiences and needs
- Selecting and adapting curriculum
- Guiding students in active and extended scientific inquiry
- Providing opportunities for scientific discussion and debate among students
- Supporting a classroom community with cooperation, shared responsibility, and respect

Assessment Standards

The programming for the summer was designed in such a way that informal assessment of student learning and understanding is part of the activity itself.

Teachers adjusted lessons to help students understand the concept, or modified the lesson to the level of the child's under-

A teacher assesses prior knowledge.

standing. Inquiry-based learning provides a rich environment for observing and assessing the student's understanding.

The learning specialist observed each activity and discussed them with the teacher to ensure they were age appropriate and engaging—and packed with learning objectives.

Revitalized Standards:

- Assessing to learn what students do understand
- Assessing achievement and opportunity to learn

Small-group activity with a 1:6 ratio.

Content and Inquiry Standards

Weekly themes were explored in each of the five learning centers. The teacher assigned to the learning center used scientific principles to guide the creation of that week's activities. Children were assigned to a three-hour morning or afternoon session, giving teachers an opportunity to develop in-depth activities. Children explored science through art, theater, games, the science center, and investigation. Sometimes participants were guided through several activities, each building on the knowledge and concepts gained in the previous activity. In some centers, students did one comprehensive activity for the entire morning or afternoon. Inquiry, small-group, and investigation-based activities were the norm for all sessions.

Small team works to redesign a Lego machine.

Test kitchen activity reaveals effect.

Revitalized Standards:

- Learning subject matter disciplines in the context of inquiry, technology, science in personal and social perspectives, and history and nature of science
- Integrating all aspects of science content


Students perform life cycle of a butterfly.


Students analyze a mystery substance.


Creative art teacher works with students.

- Implementing inquiry as strategies, abilities, and ideas to be learned
- Processing skills in context
- Using multiple process skills—manipulation, cognitive, procedural
- Doing more investigations in order to develop understanding, ability, values of inquiry and knowledge of science content
- Communicating student ideas and work to classmates

Staff Development Standards

A two-day preservice learning session was conducted for the entire summer staff. This training encompassed the same principles that governed the activities of the children. Specifically, small-group discussions and activities on the topic were the norm for all sessions. Teachers and the TAs were assigned together in groups where they interacted as peers. The small groups then reported back to the large group what they had learned and gathered in their discussions. Participants were encouraged to share personal expertise and knowledge, expanding the potential interaction with the group.

Revitalized Standards:

- Collegial and collaborative learning
- A variety of professional development activities
- Staff developers as facilitators, consultants, and planners
- Teacher as producer of knowledge about teaching

Science City Summer Director and Manager participated in a two-day training conducted by the Institute for Inquiry (based at the Exploratorium in San Francisco). This preliminary preparation was organized for informal science programs funded by the Kauffman Foundation. Activities learned were used in the preservice training with the summer staff to teach them inquiry-based science techniques.

Staff members participated in staff development sessions addressing learning theory and constructivist approaches to learning and discipline. The discussions led to practical application of these new approaches that were implemented into inquiry-based science activities. The benefits also included confidence among the staff in addressing and anticipating common issues with groups of children, and subverting behavior that could negatively impact the group's experience.

Theater T.A. guides participants.

Revitalized Standards:
- Learning science through investigation and inquiry
- Integration of science and teaching knowledge
- Integration of theory and practice in school settings
- Teacher as source and facilitator of change

Assessment and Results

Science City Summer Camp's primary goal was to offer area young people—especially those representing underserved populations—exciting, engaging, and challenging science learning experiences that could also serve as a foundation for future school and out-of-school success stories. A secondary goal was to determine what kind of infrastructure and resources would allow existing science education organizations to expand their reach on a sustained basis to students from high-poverty populations.

In 2006, the Kansas City–based Ewing Marion Kauffman foundation, the 26th largest foundation in the United States, funded seven informal science education initiatives in the Kansas City metropolitan area. The foundation's investment totaled $685,000, of which $175,000 went to Science City Summer Camp, the largest of the programs. In February 2007, the foundation received the evaluation reports on those seven initiatives they had commissioned from the Program in Education, Afterschool and Resiliency (PEAR) at Harvard University and McLean Hospital, in collaboration with the Exploratorium in San Francisco.

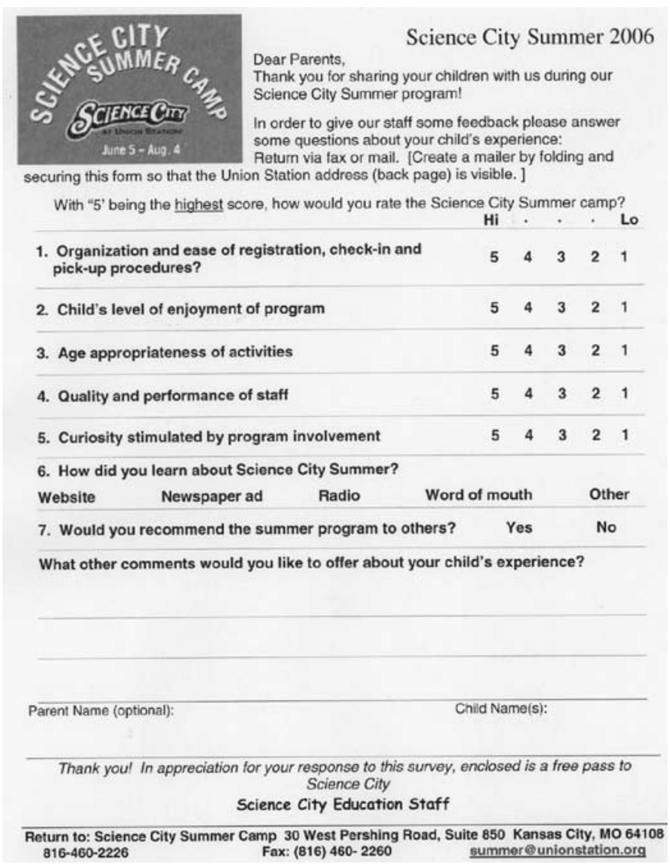
PEAR evaluators used multiple methodologies of assessment, including program observation, interviews, and qualitative surveys. They did *not* reveal individual programs in their written report, citing the "trust" developed during the process of data collection and site visits. However, they concluded that the summer initiatives were "highly positive for both the young people and the organizations that offered the programs." They further noted that organizations responded in a remarkably short time frame to expand and alter their program offerings, having started a development trajectory that will take some time to further mature.

The success of the initial 2006 offerings has led to funding for 2007 and beyond. The participating organizations are now forming a coalition to assist with program development, marketing, and sustainability. With much of the formative evaluation completed, the emphasis is shifting to a longitudinal, summative evaluation of outcomes for each program.

Prior to the Kauffman Foundation funding, the Science City Summer program was funded by enrollment fees, which excluded most underserved children. The Kauffman Foundation support has allowed the Science City Summer program to emphasize diversity by merging teaching staff and participants in a variety of ethnic and socioeconomic groups.

Science City Summer Internal Survey to Parents

An internal evaluation survey was conducted to assess participant satisfaction. These surveys were mailed to 186 families (participants not sponsored by the grant), and received 50 returns. The results provided invaluable feedback for program adjustment, as well as indicating a high degree of program satisfaction, with marks averaging between 4.0 and 5.0 in all categories.



Science City Summer 2006

Dear Parents,
Thank you for sharing your children with us during our Science City Summer program!

In order to give our staff some feedback please answer some questions about your child's experience:
Return via fax or mail. [Create a mailer by folding and securing this form so that the Union Station address (back page) is visible.]

With "5' being the highest score, how would you rate the Science City Summer camp?

	Hi	·	·	·	Lo
1. Organization and ease of registration, check-in and pick-up procedures?	5	4	3	2	1
2. Child's level of enjoyment of program	5	4	3	2	1
3. Age appropriateness of activities	5	4	3	2	1
4. Quality and performance of staff	5	4	3	2	1
5. Curiosity stimulated by program involvement	5	4	3	2	1

6. How did you learn about Science City Summer?
Website Newspaper ad Radio Word of mouth Other

7. Would you recommend the summer program to others? Yes No

What other comments would you like to offer about your child's experience?

Parent Name (optional): Child Name(s):

Thank you! In appreciation for your response to this survey, enclosed is a free pass to Science City

Science City Education Staff

Return to: Science City Summer Camp 30 West Pershing Road, Suite 850 Kansas City, MO 64108
816-460-2226 Fax: (816) 460- 2260 summer@unionstation.org

Internal evaluations were addressed at weekly staff meetings. All staff members were encouraged to contribute to the evaluation and discuss program concerns. Staff morale was enhanced through guest speakers for both inspiring and informing staff in effective teaching behaviors.

Lead teachers met separately each week to discuss and evaluate the program and assess teaching assistant performance. Meetings were scheduled throughout the summer with community partners to coordinate programming and gather feedback, then making changes as appropriate.

This ongoing assessment resulted in comments on the parents' evaluation forms, such as Maddie's mother who wrote, *"Maddie had a wonderful time. I think she learned more in one day than she did all last year in school! She had a great summer. Thank you!"* Other parents wrote:

"My kids went to several different camps this summer, but this one was by far their favorite. They were so interested in all of the activities. We will definitely be back next summer. P.S. We loved the music in the morning!"

"I thought the summer program was excellent! Allison loved the program and the staff. I truly hope you will have this next summer."

"John described this camp as the best camp he ever had gone to. He loved it!"

"Excellent camp. High ratio of instructors to students was very good. Very well organized."

"Bryanna said 'It was awesome! I loved it!' Really enjoyed making fossils. Thought all the teachers did a good job."

"He loved it! He cried on Friday because he would miss it!"

"Elise enjoyed her camp experience. She came home very excited about what she had done each day. Elise also commented on how much she liked her group leaders and TA from Creative Expressions."

This year, in addition to the ongoing Kauffman evaluation, a more structured research component being conducted by the University of Kansas Center for Science Education has been added to the program to define intended outcomes for the summer program and to assess the degree to which these stated goals and outcomes are achieved.

Program Goals and Outcomes for Science City Summer 2007

Goal 1: To provide a wide range of inquiry-based, hands-on learning activities imbedded into real-world issues.

- **Outcomes will be evidenced by:** well-developed inquiry-based STEM program material and lesson plans implemented within a clear scope and sequence

Goal 2: To provide engaging learning experiences for each child addressing a wide range of learning modalities.

- **Outcomes will be evidenced by:** inquiry-based STEM program material and lesson plans built on a learner-centered curriculum model.

Goal 3: To develop in all students a deeper interest and understanding of the natural world through the scientific process.

- **Outcomes will be evidenced by:** students who actively engage in the scientific process on their own initiative.

Goal 4: To enhance social skills that promote student social development; including the citizenship skills to live and work in a democratic society as informed decision makers, rather than just activists.

- **Outcomes will be evidenced by:** students who are actively and effectively engaged citizens.

Goal 5: To serve all segments of society by insuring participation of economically and academically underserved populations of students through partnerships with community organizations.

- **Outcomes will be evidenced by:** sponsorship through scholarship funding from community partners who serve children in the lower socio-economic groups while increasing the appeal for families who self pay.

Goal 6: To continue the development of young people through an instructional/mentoring program for teaching assistants.

- **Outcomes will be evidenced by:** well-established students as teacher models for high school and post secondary students.

Goal 7: To determine the value of these informal learning strategies by assessing the impact of this experience on their interest in science and science careers as well as their achievement/testing scores in their schools.

- **Outcomes will be evidenced by:** (proposed) a longitudinal study following these students through school and later as they make career choices.

Evaluation—A Work in Progress

Personnel with the Center for Science Education at the University of Kansas will be conducting the external summative evaluation of the stated program goals and outcomes for the 2007 period. Preliminary interviews and surveys will establish an assessment baseline.

A major goal for Science City Summer Camp is to introduce and inspire elementary-age students to consider advancing their education and select careers in science. Students and TAs in the program will be exposed to science through nontraditional, hands-on, inquiry-based experiences. The evaluation will measure the long-term effect of this informal summer education program. The summative evaluation design will recognize the impact of this opportunity for students at several levels: (1) Student participants will be between the ages of 6–12 years; and (2) the TAs range from high school to early college age. The evaluation will explore changes in attitude toward science, career interests, and school success with both student participants and TAs. To that effort, the children in the program will be surveyed and interviewed for their attitudes toward science and mathematics and the likelihood that they will consider a career in these areas. Those children that continue in the program for multiple years will be tracked for changes in these attitudes having experienced the enrichment classes.

The TAs will be assessed for the impact that the *students as teachers* curriculum models on their attitudes toward science and math, and school achievement in those areas. The leadership role experienced by the TAs will be factored into attitudinal changes and confidence in pursuing careers requiring higher education.

Parents of all the participants (students and TAs) in the study will also be surveyed for changes in their child's behaviors concerning science and mathematics over the course of these informal science experiences.

The Next Step

This type of enrichment camp experience, delivered in an informal setting, goes well beyond the expertise and abilities of most schools' educational programming. The question becomes: What is the educational value of such summer science and math enrichment experiences? The real answers, for now, remain unknown. There are several important requirements for a definitive baseline study aimed at determining the value of these programs. A longitudinal study, spanning a period of at least 3–5 years, would assess the following:

(1) How do children involved in enrichment informal programming compare, educationally and developmentally, with their peers who do not attend such programs?

(2) How can we obtain data from populations that are significant, but not easily available for study, such as children attending care centers?

(3) How does the experience of being Teaching Assistants affect their career and higher education choices?

(4) How does teaching in informal enrichment programs affect teachers' instructional behavior and outcomes in formal education settings?

The answers derived will be very important in developing effective models for educational change and reform. If found to help achieve significant educational gains, for example, informal education programs could partner with schools to provide a very cost-effective means of boosting student learning and teacher effectiveness.

The future of Science City Summer is as exciting as the past few years. There is a natural niche for informal programs to exist alongside traditional summer school programs and in after-school programs. The development team is already planning how to disseminate the program by partnering with other informal and formal education settings to deliver a new attitude of science and education for Kansas City's children—and beyond.

Grands Are Grand:

A Cross-Generational Learning Experience at the North Museum of Natural History & Science

Esther D. Wahlberg
The North Museum of Natural History & Science

Grands Are Grand is a monthly program for children ages 3–5 and their grandparents offered by the North Museum of Natural History & Science in Lancaster, Pennsylvania. This program reflects the Museum's commitment to providing engaging informal science experiences for all ages.

The North Museum's mission is to "promote lifelong learning throughout the community by generating excitement and curiosity in the natural and physical sciences and technology." This community museum has provided personal educational experiences to adults and children for more than 50 years and its heritage collection goes back hundreds of years. In the late 19th century, Lancaster County was home to an active group of naturalist-collectors called the Linnaean Society. In time, this organization's rich and varied collections were entrusted to Franklin and Marshall College, who built the Museum in 1953. In 1992, the museum was reorganized and incorporated as an independent nonprofit institution.

Today, the museum serves the region as its only natural history and science museum and planetarium. It preserves and protects over 350,000 objects organized into major collections of regional archeology, botany, geology, mineralogy, mammalogy, ornithology, and paleontology. A recently refurbished planetarium is Central Pennsylvania's largest, and is the centerpiece of the museum. The North Museum is conveniently located within the City of Lancaster and is fully accessible. Excellent programs, generous admission policies, and a comfortable and inviting environment—all of these qualities contribute to the museum being named Lancaster's favorite museum for the fourth year in a row.

Grands Are Grand programs utilize both the Museum's authentic objects and touchable specimens, including pelts, skeletons, casts, and models for hands-on exploration.

National Science Standards Blueprint for Change

The *Grands Are Grand* program has placed specific emphasis on the following components of the NSES:

- Teaching Standard: Guiding students in active and extended scientific inquiry.
- Content and Inquiry Standards:
  (1) Understanding scientific concepts and developing abilities of inquiry;
  (2) Studying a few fundamental science concepts (relationships in nature);
  (3) Creating activities that investigate and analyze science questions; and
  (4) Using multiple process skills—manipulation, cognitive, procedural.

Three lessons are included to illustrate this emphasis. They are titled *Susie-Q*, *Snakes and Spirals*, and *Frogs*.

Guiding Students in Active and Extended Scientific Inquiry

Grands Are Grand lessons include a wide variety of touchable, visual, and audible materials that present opportunities for active exploration and learning. Children are able to touch live animals (*Snakes and Spirals*), feel their skins and skeletons, and watch how they move. The literature selections used to introduce children to topics actively involve listeners in new worlds. Puppets enable young children to relate to animals and create concrete experiences otherwise unavailable to them, such as the comparison of frog and toad skins (*Frogs*). Active learning may also be presented in the form of a self-correcting puzzle (*Frogs*) or using a chocolate chip cookie to pretend you are a paleontologist (*Susie-Q*). By mixing formal presentation with active engagement, the program focuses on the needs of preschool children.

Extended scientific inquiry has always been an important aspect of *Grands Are Grand*. Since the program's inception, take-home activities (such as puzzles, games, baking experiences, poetry) have been included with each lesson to reinforce the lesson objectives and provide additional sharing opportunities for grandparent and grandchild. The museum, particularly in its Discovery Room, offers many opportunities for extended learning for young children. Grandparents are given suggestions on how the experience can be extended using museum exhibits and resources.

Grands Are Grand maintains a consistent focus on the concept of relationships in nature. Lessons pertaining to animal life emphasize predator/prey relationships, the connections between anatomy and survival, as well as habitat and life-ways. Botany lessons have a strong life cycle component. Understanding that fossils are a part of the terrain (*Susie-Q*) further develops the connection between living things and their habitats. Examples of these connections are woven throughout the included sample lesson plans. Our focus on relationships in nature emphasizes structure and function, variation, and diversity.

Although *Grands Are Grand* content varies, relationships in nature are consistently explored. Since grade preK children are actively learning about themselves and their world, learning about the relationships of other living things is an age-appropriate theme. The National Center for Science Education recommends nine scientific concepts for elementary school curricula. Our focus is on three of these: structure and function, variation, and diversity.

With some guidance, preschool children make effective comparisons to investigate and analyze science questions. For example, they are able to compare the size of the front and hind legs of frogs (*Frogs*) and determine why the strong hind legs are important. Grandparents effectively prompt this thinking process and work within their grandchild's particular abilities.

Hands-on learning is a critical component of *Grands Are Grand* programs. Children benefit from the Museum's extensive materials that they can handle and explore. Problem-solving activities begin with the literature component of each lesson because children are asked to predict outcomes. This continues through science activities that require comparisons and conclusions. *Grands Are Grand* introduces children to classification by considering species when looking at groups of similar living things. For example, frogs are introduced as amphibians and snakes as reptiles.

Program Description

Goals

Grands Are Grand is a monthly program for children ages 3 to 5 and their grandparents designed to develop curiosity and excitement about the natural world while providing multigenerational sharing and problem solving opportunities. Instruction is aimed primarily at the children. The program is based, in part, on Vygotsky's social cognition learning model and zone of proximal development. "The zone of proximal development bridges the gap between what is known and what can be known. Vygotsky claimed that learning occurred in this zone" (Riddle and Dabbagh 1999). Grandparents' understanding of their grandchildren's abilities and guidance through the zone of proximal development is key. *Grands Are Grand* recognizes varied learning styles and provides concrete materials and movement opportunities that reflect the needs of young learners.

Grandparents and grandchildren examine a bull skeleton following a reading of a grandparent favorite, *Ferdinand the Bull*.

Grands Are Grand also aims to rekindle or supplement grandparent interest in the natural world and the museum. The informal atmosphere lends itself to questions and discussion between the adults and the instructor. Grandparents have commented on their own learning experiences during the programs.

Relying, in part, on the writings of psychologist Mihaly Csikszentmihalyi, Caryl Marsh writes in *Visitors as Learners: the Role of Emotions* (1996), "There is strong evidence that visitors go to museums seeking enjoyment and understanding. These two factors seem to interact in a reciprocal fashion. The more enjoyment, the more likely there will be learning. The increased learning and understanding lead to more enjoyment." The relationship between grandparent and grandchild brings a high level of enjoyment and pleasure to *Grands Are Grand* classes.

In addition to the museum's educational goals, *Grands Are Grand* addresses three of the museum's strategic objectives. First, the museum was attracting substantial interest among active seniors of Lancaster County and additional programs were needed to meet the demand. Second, the museum's literature-based programs for preschoolers had been successful and *Grands* responded to current emphasis in formal education. Third, by providing programming during off-peak hours, the museum more fully utilized its limited space.

Setting, Environment, and Schedule

Grands Are Grand is offered in the North Museum's Kinsey Community Room, a multipurpose meeting room located on the second floor of the museum. The room is carpeted, comfortable, and inviting. An effort is made to create a warm and intimate setting.

To encourage multigenerational sharing and a friendly atmosphere, children and grandparents are seated next to each other at rectangular tables. The small group size (maximum 28 grandparents and grandchildren) contributes to the nonthreatening environment. Puppets are often used to welcome children or may be incorporated into the lesson.

Consideration is given to the needs of working parents. *Grands Are Grand* programs are presented Friday afternoons at 4:00 pm. While grandparents spend quality time with their grandchildren, busy parents can get a little time to themselves at the end of a stressful week. The late afternoon classes follow afternoon or whole-day school programs. A consistent schedule, every third Friday, enables families to plan *Grands Are Grand* attendance well in advance.

Varied Curriculum

To date, more than 40 individual *Grands Are Grand* programs have been offered. Age-appropriate topics have been selected to incorporate museum collections and coordinate with museum exhibitions. For example, during our 2005–2006 yearlong celebration of spirals in nature, the programs *Spirals: Whirls Without End*, *Snakes and Spirals* and *Along Came a Spider* were added.

In addition to topics relating to animals—their characteristics, adaptations, habitats and relationships to each other—the following subjects have also been offered: botany, astronomy and meteorology, paleontology, physical sciences, math in nature, and natural history museums.

Grands Are Grand Lessons: July 2003–November 2007

2003	July	*Meet the Snakes*
	July	*Hoot, Hoot*
	October	*Hoppin' Into Science: Frogs and Toads*
	November	*Growl-l-l! Grand Bears for Grand Kids*
2004	January	*Weasily Weasels*
	March	*Moth or Butterfly*
	April	*Springtime is Planting Time*
	May	*Puffy or Spikey: Pufferfish*
	June	*Imagine: Mollusks*
	July	*Clouds: Pictures in the Sky*
	September	*Be Your Grandparents' Tour Guide*
	October	*Bats and More*
	November	*Swooping Down From the Sky: Raptors*
	December	*Wintry Menu*
	December	*Party Sounds*
2005	January	*Megasharks*
	February	*Be An Astronomer*
	March	*Susie-Q: Fossils to Museums*
	April	*Dinosaur Families*
	May	*Blue Feet, Blue Tongues, and Other Oddities*
	June	*Nature's Apartment: Trees*
	July	*Hives and Ant Hills*
	August	*Beach Homes*
	September	*Snakes and Spirals*
	October	*Along Came a Spider*
	November	*Penguin Families*
	December	*Trees: Alike & Different, Conifer & Deciduous*
2006	January	*Backyard Winter Birds*
	February	*Snuggles*
	March	*Eggs, Eggs, and More Eggs*
	April	*Springtime is Planting Time*
	May	*Hoppin' Into Science: Frogs & Toads*
	June	*Hide & Seek: Animals Under Rocks*
	July	*Incredible Insects!*
	August	*Let's Celebrate Winter in the Antarctic!*
	September	*Squirrels and Nuts*
	October	*While You're Sleeping: Nocturnal Animals*
	November	*The Otter's Susquehanna River Feast*
	December	*Pine Cones: On the Tree, on the Ground, and in our Hands*
2007	January	*Wintry Menu Along the Susquehanna River*
	February	*Ferdinand and His Big, Big Bones*
	March	*Turtles, Turtles and More Turtles*
	April	*Fossils Found in Pennsylvania*
	May	*Flowers and Bees; Helping Each Other*
	June	*Crunchy Critters in the Susquehanna River*
	July	*Maize; Then and Now*
	August	*Pictures in the Sky: Clouds*
	September	*Animals With Pouches: Near and Far*
	October	*Magnets Everywhere*
	November	*Petroglyphs*

Lesson Components


After learning about pinecones, grandmother and grandson collaborate on a creative project.

Each *Grands Are Grand* lesson is divided into three major components: children's literature, a science activity/lesson, and a craft. Take-home activities and suggested reading lists are provided at the conclusion of each class.

(1) *Children's literature.* Following introductions, the chosen literature selection focuses everyone's attention on the topic. The story is presented with children seated on the floor in a circle. Questions and active participation are encouraged and, occasionally, puppets are used. Books are selected based on the presentation of accurate scientific content combined with an imaginative story.

Grandparents provide encouragement to children who may be reluctant to join the circle. At the conclusion of the story, children return to their seats and comments are often exchanged between grandparents and grandchildren, reflecting on content, illustrations or other aspects of the literature selection.

(2) *Science activity/lesson.* Real specimens, hand-held magnifiers, replicas, puppets, photographs, and audio equipment are used to present science concepts. Songs and finger plays may be included. Children and grandparents are encouraged to handle touchable objects while fragile specimens are made available for up-close observation. Concrete experiences, such as petting a live snake, sitting on a polar bear pelt, and examining owl wings and fossils enable children to compare and analyze adaptations. Children and grandparents may participate in experiments that facilitate greater understanding of adaptations. Varied topics, vocabulary, and experiences encourage thinking about broad themes pertaining to relationships in the natural world such as predator and prey, life cycles, and the relationship between wildlife and human beings. We introduce children to natural history vocabulary such as "specimen" and "replica."

Sitting close to each other, grandparents and grandchildren share by handling objects together. Grandparents intuitively individualize their instruction according to their grandchildren's level of knowledge and provide them with the appropriate level of assistance.

(3) *Craft.* Using a craft as a concluding activity enables grandparents and children to be creative together while reinforcing science knowledge. Puzzles, matching activities, and books are available for those young children who may have less interest in crafts.

Sample Lesson Overviews

Susie-Q for Grands: Fossils to Museums

As they arrive and sit down, each child is provided with a chocolate chip cookie and toothpicks and is challenged to dig out chocolate chips without breaking them. Children are asked not to eat the cookies until later. Visitors respond excitedly to working with something familiar and tasty and begin a collaborative project, with grandparents frequently functioning as coaches, suggesting a slow and patient effort. When children are asked if they were able to dig any chips out without breakage, they respond eagerly and may count the chips. Sometimes the chips mysteriously vanish, creating a light touch to the start of this lesson. Children are eventually allowed to eat their cookies. This activity offers an opportunity to connect the delicate work of paleontologists to the child's own experience.

Reading *The Field Mouse and the Dinosaur Named Sue* leads to discussion of fossilization, specimens, and models. Looking at a partially fossilized porcupine skull helps children understand the fossilization process and also illustrates the fact that the animals that formed the fossils of today were, at one time, alive. Grandparents' fascination with the porcupine skull adds to its impact.

While additional objects are being handled, future visits to our own Dinosaur Hall are encouraged for extended learning. The Discovery Room, with its fossils discovery box, is suggested for additional hands-on exploration.

Skulls and footprints and their connection to herbivore and carnivore classifications are used to represent knowledge gained from fossils. Grandparents and grandchildren use herbivore and carnivore dinosaur footprint shapes to create stories. Children may step into an authentic *Allosaurus* footprint and compare actual sizes.

The clay and shell fossils made in class are taken home and serve as prompts for discussion, reading, additional museum visits and, of course, memories of a happy time at the museum.

Snakes and Spirals for Grands

The life-sized boa constrictor puppet welcomes children. Manipulating the puppet can immediately introduce children to spirals. Curiosity is indicated by the children's questions relating to the size and color of snakes.

Children's literature is used to introduce key concepts of this lesson. The setting for the children's story *Crictor* is Paris in the early 20th century. Characters are fictional and illustrations look like cartoons. The title character is a pet boa constrictor whose agile spine enables him to help children learn as he forms letters and numbers and who saves the day by wrapping itself around a burglar. Children participate in the story by saying letters and numbers, giggle when they see Crictor's very long bed, frown and show concern when the burglar appears, and sigh with relief when they learn of the snake's ability to defend its owner's home. The word *constrictor* takes on meaning visually and also reflects this important ability. Using visuals at the conclusion of the story easily connects the constrictor's shape to spirals.

After children rejoin their grandparents, constrictors are differentiated from venomous snakes and everyone is allowed to get a close look at a preserved rattlesnake while shaking a snake rattle. Predator and prey relationships are a natural part of the comparison between constrictors and venomous snakes.

Children are assured that there are no live venomous snakes at the museum and are introduced to a living ball python. Visitors watch intently as the snake curls and uncurls while the instructor holds it and describes the animal's anatomy and survival techniques. Everyone handles shed snakeskin and has the opportunity to touch the python in order to feel its skin and its long spine. Some people are reluctant, others are eager, and children and grandparents benefit from each other's curiosity and bravery.

While distributing materials for the spiral snake craft, the instructor may ask questions to determine if children understand that spirals are similar to circles within each other and that constrictors form spirals to catch their prey. As they provide support with cutting projects and feedback regarding coloring efforts, grandparents frequently repeat the vocabulary. Children and grandparents may also go to the table where skins, skeletons, and specimens are displayed and may make a snake skeleton rubbing.

Take-home materials include a Slithering Snake Cookie Recipe, a baking activity that encourages conversation about snakes and perhaps another visit to the Museum's live animal collection.

Frogs for Grands

Frog and toad puppets welcome children and quickly illustrate differences in size and skin texture. Seated at tables while waiting for others to arrive, children and grandparents work collaboratively on a self-correcting frog life cycle puzzle. They may also use magnifiers to look at the plastomounts on each table. "Is this real?" and "Why did you kill it?" are frequently asked questions when children are first exposed to plastomounts. They are assured that museum staff like to have animals live in their natural habitats and that we do not kill animals. Sometimes the children's questions lead to a discussion of how animals die.

Bullfrog at Magnolia Circle, a Smithsonian's Backyard book, illustrates the beauty and danger of life in a bayou. As the plot unfolds, predator and prey concepts are easily emphasized.

After returning to tables, the frog and toad puppets are reintroduced and touched. Differences in size and skin texture are discussed. Lyrics to "The Skin Song" are distributed to grandparents, and the adults smile broadly while they sing to the tune of "London Bridge" as follows:

The skin of a frog is moist and smooth,
Moist and smooth,
Moist and smooth.
The skin of a frog is moist and smooth,
My fair froggie.
The skin of a toad has warts and bumps,
Warts and bumps,
Warts and bumps.
The skin of a toad has warts and bumps,
My fair toady.

Children join in for the repeat performance, a fun-filled, shared learning experience that can be repeated at home.

As children look at the toad skeleton and various plastomount specimens, they are asked to compare front and hind legs and consider why this difference in size exists. With the help of grandparent prompts, children often arrive at the conclusion that frogs and toads need large and strong hind legs to jump and spring.

Life cycle plastomounts, plastic manipulatives, and the puzzles handed out at the start of class illustrate frog development. Comprehension of this process is assessed when children are asked to use their bodies to show how a frog might grow. They are asked to curl up in a ball to represent the egg and, when asked what happens next, they lay down and swim like tadpoles and, eventually, jump like frogs. Like "The Skin Song," this activity may be repeated at home.

The grandparents' capable one-on-one guidance is important to the successful completion of the paper bag frog puppet. As grandparents' play with their grandchildren, their imaginations and knowledge prompt dialogue with the puppet that reinforces vocabulary and concepts.

Assessment

Monthly *Grands Are Grand* programs are independent of each other and, therefore, attendance varies. Teachers observe behavior throughout the lesson and especially during concluding activities to assess comprehension, such as, at the end of the *Frogs* lesson when children are asked to dramatize the frog life cycle.

Over a third of grandparents who come to *Grands Are Grand* return for another program and 11% bring grandchildren to five or more programs. Some grandparents have brought consecutive grandchildren to *Grands* after their first grandchild has reached age six. Observations show that returning children happily walk into the Kinsey Room and are increasingly more willing to join the story circle, handle animals and specimens, and more frequently speak of showing craft projects to their parents. Returning children are also increasingly willing to participate in discussion, and their questions and responses indicate awareness of relationships in nature. For example, returning children ask how a specific animal defends itself or what it eats. Smiles and verbal indication of interest in attending subsequent programs show that *Grands Are Grand* is an enjoyable experience for grandparents and grandchildren.

The North Museum is currently looking at all of its educational offerings to ensure that programs are meeting audience needs. To that end, a comprehensive member survey has just been created and a specific summative evaluation has been distributed to participants of *Grands*. Participants ranked program features as "not valuable," "somewhat valuable," and "very valuable." Storytelling, handling real objects, take-home activities, and facilitator/leader are features that were all ranked "very valuable." A majority of grandparents indicated that the 45-minute class is an appropriate length for their grandchildren. Typical comments reflected grandparents' interest in sharing experiences with their grandchildren, fostering their grandchildren's learning, and continuing their own learning. Comments included "Excellent learning-bonding experience," "Fabulous. I always learn something," and "Very interesting, valuable, hopefully will foster an interest in science."

The museum offers an opportunity to purchase a Grand family membership that families greatly appreciate. We believe that *Grands Are Grand* has had a positive impact on the purchase of such memberships and has brought older residents of Lancaster County to the museum for repeat visits.

Future Plans

Grands Are Grand programs will continue to provide diversification of topics and coordinate with the Museum's new permanent exhibition *Natives of the Susquehanna*. Future programs will expand our offerings in anthropology, botany, meteorology, paleontology, and physical science.

Grands Are Grand programs have been done in cooperation with the Lancaster County Public Library and this will continue. Suggested reading lists are being included in take-home materials.

Future plans also include teacher training which will incorporate continued emphasis on guiding students in active and extended scientific inquiry.

Summary

As noted earlier, the North Museum's mission is to "promote lifelong learning throughout the community by generating excitement and curiosity in the natural and physical sciences and technology." *Grands Are Grand* presents an informal learning environment that benefits the very young as well as adults continuing to learn.

Grandparents support their grandchildren's learning in two significant ways: They help create a supportive and encouraging environment and they individualize instruction by guiding and helping children through specific tasks, as needed. Since "child-teacher interaction is a primary mechanism through which classroom experiences have effects on development" (Pianta 2003), this grandparent-assisted instruction positively affects learning.


Sharing a hands-on science experience.

Grandparents also benefit from the program in two distinct ways. First, they have an opportunity to share, influence, and continue a unique learning experience with their grandchildren. Second, their own knowledge and appreciation of the natural world is enhanced or reaffirmed. Research has indicated that instruction of older adults "should take place in stimulating environments; e.g., hands-on settings, group learning, high interactivity with the curriculum, many and varied visuals, tailored feedback, intergenerational situations" (SPRY Foundation 1999). *Grands Are Grand* lessons will continue to fill several of these criteria.

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