An Intergenerational Approach to Informal Science Learning and Relationship Building Among Older Adults and Youth

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ABSTRACT. One of the challenges that affect educators in many fields is how to achieve and sustain participation in active learning throughout the life span. The SPRY (Setting Priorities for Retirement Years) Foundation addressed this challenge by creatively combining inquiry-learning techniques from informal (out of school/free choice) science education (ISE) with specially designed intergenerational programs that brought together youth and older adults for co-learning experiences. SPRY explored this concept by applying knowledge and techniques from SPRY’s previous research in older adult learning to ISE topics. The results show impressive yields in social and cognitive benefits both for youth and older adult participants. doi:10.1300/J194v05n03_03 [Article copies available for a fee from The Haworth Document Delivery Service: 1-800-HAWORTH. E-mail address: <docdelivery@haworthpress.com> Website: <http://www.HaworthPress.com> © 2007 by The Haworth Press, Inc. All rights reserved.]
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INTRODUCTION

Educators have long recognized that much of what individuals of all ages learn about science occurs in informal settings (American Association for the Advancement of Science, 1989; Anderson, 1998), from museums to nature trails. A student’s science education outside school can reinforce classroom lessons (Delacote, 1998), while community-based science experiences offer lifelong learning opportunities for older adults (Hart, 2002). In the years to come, students will need to prepare for increasingly competitive economic and intellectual markets more dependent than ever on science and technology skills. At the same time, the aging and ever-curious baby boomers will be searching for new avenues of intellectual stimulation, even as the generation following them seeks ways to keep current with marketable career skills and needs (Adler, 2002). The purpose of this article is to describe the rationale, design, results, and key learnings of an innovative intergenerational program called Science Across the Generations (SAG) that was developed by the SPRY Foundation, Washington, DC, in collaboration with its partner, the OASIS Institute, St. Louis, MO, using a grant from the National Science Foundation. The program was tested at various locations in the U.S. over a 3-year period, from 2002 through 2005.

VALUE OF THE INFORMAL SCIENCE EDUCATION (ISE) APPROACH

While numerous intergenerational programs for older adults and children exist, these programs do not integrate ISE components nor engage the two groups as learning partners. An extensive search located only two prior examples (Explorit Science Center, 2000; Goff, 2004). Typically, older adults serve as tutors or mentors, which may create an inhibiting barrier to opportunities for shared learning.

Older adults may benefit from the mental stimulation that comes from exchanging ideas with children and hearing their creative challenges to accepted facts (Fried, 2004; Rowe, 1997). Children benefit from the life experience an older person brings to discussions, where a simple example from a real-life situation can make scientific terminology more
understandable (Ramey-Gassert, 1997). And the community benefits from the social cohesiveness of long-term shared learning between generations (Chasteen, 2002).

The very nature of ISE encourages the disappearance of boundaries, sharing of information and an enthusiasm that sparks the mental processes (Callanan, 2001). In formal science education, students are given facts to learn using a controlled methodology. ISE uses an exploratory, self-motivated approach (Crowley, Schunn, & Okada, 2001). Students choose what they want to learn from among several aspects of one topic and the self-motivation resulting from this choice drives their inquisitiveness to learn more (Crowley & Galco, 2001).

This is especially true in science education, where a more informal methodology engenders a recognition of the role science plays in everyday life, as well as how the techniques used in learning science—observe, ask questions, gather evidence, draw a conclusion—can be applied to other areas of day-to-day living.

**SCIENCE ACROSS THE GENERATIONS LEARNING APPROACH**

In developing SAG, the SPRY Foundation took note of several recent studies whose findings demonstrated the following:

- Children’s science learning can be more effective when taught in the context of collaboration (Callanan, 2001).
- Families, including grandparents, play an important role in enriching children’s ability to make inferences and construct theories (Crowley & Galco, 2001).
- A learner-centered model for ISE is important to both younger and older learners (SPRY Foundation, 1999).
- Science learning can be engaging, enjoyable and non-threatening (Ramey-Gassert, 1997), all characteristics important to young and mature learners.

It was decided to use both a workshop approach and a tutorial approach for following reasons: (1) Both networks were already in place through SPRY’s partner, the OASIS Institute, and (2) This would provide data to compare the opportunities of learning in both settings. Twenty informal science curriculum modules were developed, field tested, and evaluated in the workshops and tutoring sessions over a 3-year period (see Box 1).
BOX 1. Science Curriculum Models Developed over a Three-Year Period

The following modules were developed, field tested, and evaluated over a 3-year period:

**Airplane.** What makes an airplane fly? Explore how lift and drag, design, air flow, and shape affect flight. Learn how pilots control the plane, and how design affects steering. Learn about the design elements that enable the plane to fly straight, and the types of materials that must be put into consideration when building an airplane.

**Animal Behavior.** Animal behavior describes the actions that animals take in order to survive and reproduce. Why do some animals hibernate? How do they get their food? Learn how animals play, blend in with their surroundings, find mates, fight competition, and care for their young.

**Art and Science.** What is the science behind creating art? Why do oil paintings take longer than water colors to dry? Learn how different mediums have different chemical and physical properties. Learn to mix and separate colors by using chromatography.

**Birds and Beaks.** Birds, with their wide variety of beaks and feet, are a wonderful example of how species adapt to their environment. Learn why some beaks are long and pointy, while others are hooked or scoop-shaped. Explore the different types of feet birds can have and how their feet have adapted to the birds’ surroundings.

**Growing a Garden.** What do you need to grow your own garden? Light, soil, and water. But how much light, what type of soil, how much water? Learn about the life cycle of plants, why some have flowers and others don’t, and the important role of flowers. Use a soil percolation test to find out how well the soil holds water, and a zoning map to understand which plants grow best in which climates.

**Moon.** Why does the moon appear to be “larger” some nights than others? Learn about the exploration of the moon, its features and landscape. How do shadows play a role in how we see the moon? How does the moon affect the changing of the ocean tides?

**Making Music.** Why does everyone have a different voice? Explore the relationship between vibrations and pitch, and the physical, mathematical, and technological factors behind the sounds made by musical instruments. Use everyday objects to make your own musical instruments.
Getting and Staying Healthy. What does it mean to be healthy? What is exercise and what can it do for your body? Learn how to control your diet, find time to exercise, learn about risk factors and avoid communicable diseases. Why do some people need more (or less) food than others? Keep a diet journal and learn to understand nutrition labels.

Wind. Why is it windy some days and not others? What “makes” wind? How is wind measured? Make your own windmill and learn how we can harness wind’s energy to make products and produce electricity.

Math and Money. Are you a spender or a saver? Why do we have banks? Learn about the history of money, different types of currency and how it has been used over the years. Find out how to set up a simple financial plan and how to balance a checkbook.

Ocean Oasis. What is an oasis? Learn about Baja California, its unique ecosystem and how it was formed. Learn how living things interact with their surroundings, about convection currents and their effect on ecosystems, and why certain living things seek warm water habitats.

Kitchen Science. Investigate the physical and chemical changes that take place when ingredients are combined when preparing foods. How does a bowl of batter (thick, dense liquid) become a delicious birthday cake (golden brown, light and fluffy)? What effect does heat have on the chemistry of the foods we eat?

Weather Watchers. Why do seasons change? Why does what the weather is doing (rainy, sunny) depend on where you live? Learn about weather and about the water cycle and why it happens. Watch how rain is made.

Design of Everyday Things. Examine everyday objects for their design elements, compare similar objects with different designs to determine which is more effective and why. Why isn’t a fish kept in a hamster cage? Why is paper stronger when it’s dry than when it’s wet? What are the elements that make design work?

Science of Color. How is a rainbow formed? Why is the sky blue? How are we able to see different colors? Learn the difference between the primary colors of art and the primary colors of light. What are some of the instruments and appliances that use light. Learn about refracted, or bent, light by producing colors through water or glass.

Playing with Light. How do your glasses help you see things more clearly? How does the fun house mirror work? Why do telescopes help you see items
BOX 1 (continued)

that are far away while microscopes help you see things up close? How do satellites transmit over such long distances?

_Rocks and Minerals_. What is the difference between a rock and a mineral? What are the three types of rocks and how are they formed? How do you identify rocks and minerals? How are rocks and minerals used in everyday life? Learn how to start your own rocks and minerals collection no matter where you live.

_Architecture_. How do builders, designers, carpenters, plumbers, and electricians come together and work as a team to build a building? What keeps skyscrapers from falling over? What are the best materials for building a house? A parking garage? A football stadium?

_Solving a Mystery_. How do detectives use forensic science to find clues to solve a mystery? What is a clue? How does one determine what is important evidence and what is not? What can hair and fibers and other small clues tell us about the scene of a crime? Why is it fingerprints can be useful in solving a mystery? Find out what type of fingerprints you have.

_Fossils_. How is a fossil formed? What conditions must be right to form a fossil? How are fossils so carefully protected and preserved for millions of years? Learn how to make your own "fossil" and how to tell what you are looking at when you find one.

At the end of the project, all of these modules were revised, based on feedback from workshop leaders, tutors, staff and participants. The modules are available from the SPRY Foundation, www.spry.org.

module included 4 hours of content, with 3-5 components to each, including videos and learning by doing.

In the workshop approach, children aged 5-13 were paired with older adults, aged 50 and above, in engaged co-learning activities based on one or more of the modules, lasting 1-2 hours. Participants were given their choice of which modules they wanted to participate in, with different modules being offered at different times of the year. Workshop segments—engagement, exploration and application—were led by an experienced facilitator, usually a teacher with some background in the area of the topic. In these interactive environments, more emphasis was put on visual and tactile activities than on reading.
The 189 intergenerational co-learning workshops that took place during the 3-year program were held during non-school hours in out-of-school environments, such as OASIS centers and other community locations. In the workshops the children and adults worked together as equal partners, ideally one-to-one but sometimes with two children for every adult.

In the tutorial approach, the older adult assigned to a child as tutor worked with the child once a week, using books and activities based on module topics, to improve the child’s reading skills. Tutor packets provided support for four components—reading, talking, writing, and using new words—with informal science materials. A total of 1,471 tutoring sessions took place during the same period. One-on-one tutoring sessions during school hours were arranged, with one older adult assigned by a teacher to work with one child once a week at school for the entire school year.

The tutoring and workshop activities directly reached 8,709 people, of which 6,929 responded to evaluations. Many more people were reached indirectly: 104,000 exposures to project activities have taken place through tutoring and workshops in addition to numerous other indirect avenues such as field trips, targeted community events, and the OASIS website.

**SCIENCE ACROSS THE GENERATIONS**

**EVALUATION APPROACH**

The 20 SAG modules were tested in two settings: school reading programs and community-based workshops. In the tutor setting, the intergenerational approach using tutor packets that were developed for each module to support weekly tutoring sessions during the school year was tested. The components included reading, talking, writing, and using new words with informal science materials. The children (N = 1,568) and older adult participants (N = 1,471) in tutoring sessions completed post-assessments only, due to constraints imposed by the program and by the schedule.

In the second setting, community workshops, an intergenerational approach that brought children together with OASIS volunteers for 1 or 2 hours of inquiry-learning group activities at OASIS centers or other community settings was tested. The children (N = 2,535) and older adult workshop participants (N = 1,355) completed pre-assessments at the beginning and post-assessments at the end of the activity.

Due to concerns about participants’ privacy, no specific information on older adult personal characteristics was collected during workshops.
or tutoring sessions. However, an OASIS member demographic indicates that the vast majority of members are female (76.2%), 55.5% are of 71 or more years of age, 46.7% have a bachelor’s or graduate degree and 88% are Caucasian.

Another key evaluation tool was an outcomes survey designed to elicit follow-up information from older adult participants who had attended at least one workshop or at least one tutoring session during the project. The survey was conducted in the third quarter of Year 3 of the project. The response rate was 24% (N = 137) for tutors and 22% for workshop participants (N = 152). A test-retest reliability study (N = 77) was conducted for the outcomes survey instrument. The items in the survey were reliable, with coefficients running from 0.72 for education level to 0.78 for prior training in science and 0.96 for gender.

A total of 2,826 older adults provided post-assessment evaluations after workshops and tutoring sessions; 4,103 children, 73.6% of whom were less than 9 years of age, provided responses to the pre- and post-workshop evaluations.

SCIENCE ACROSS THE GENERATIONS EVALUATION RESULTS

The findings of the various evaluation components are summarized in terms of the impact of the intergenerational experience on older adults, children, and the intergenerational field.

Impact as Reported by Older Adults

• About three-quarters of older adult respondents (75.7%) reported that they learned something new about science and 56.2% learned something new about scientific problem solving.
• A majority (58%) indicated that they were interested in learning more about science and had a more positive view of science (67.9%) after participating in Science Across the Generations.
• A majority reported that they (57.1%) and the child with whom they were working (80.8%) positively changed their beliefs about the role of science in everyday life, and also about the role of science in society as a whole (54.3% adults, 72.7% children).
• A majority (71.2%) indicated that they increased their ability to relate to children, while 45.2% felt that they interacted better with
others in the community, and 50.9% felt a greater connectedness to the community after their participation.

- More than three-quarters of post-test evaluation respondents (76.5%) indicated they would attend similar programs in the future and would recommend the SAG program to others (60.9%).
- Of those attending workshops, 78.7% reported that they were very interested in the session, and a majority (63.9%) thought that the child was very interested in the session.
- Nearly half (48.0%) thought that their knowledge of the subject had increased a great deal, and 63.9% thought that a majority of the children increased their knowledge.
- At least 70% of the respondents reported that the children with whom they worked learned a great deal from 19 of the 20 module topics. The only exception was the Wind module, rated by 68% of adults as increasing knowledge for children a great deal.

These findings demonstrate that the intergenerational ISE learning approach resulted in significant gains in science knowledge, attitudes, and beliefs for older adults and children. These results also help explain why the older adult participants believed that they and the children with whom they worked benefited from the SAG program. SPRY found that older adult participants rated the education materials and activities highly, believed that they had learned something and that generally the children had learned a great deal.

As shown in Figure 1, older adult participants with lower education levels were more likely to report learning something new about science (89.9% for high school graduates vs. 63.5% for college graduates). High school graduates were also more likely to indicate that their view about the role of science in society had positively changed, compared with college graduates (64.3 vs. 41.3%).

These findings suggest that the intergenerational ISE approach was shown to be particularly effective for older adults with low education levels, a typically hard to reach ISE population.

- In nearly all variables measured, workshop participants reported statistically higher ratings compared to tutor participants related to learning about science, interest in learning more, positive attitudes toward science, views of the role of science in everyday life, and increased perceptions that participation was a way of contributing to the community.
Some items showed striking differences between the workshop and the tutor conditions. For example, 81% of older adults in workshops thought that the view of the child or children with whom they participated regarding the role of science in society had changed, as compared to 62.8% of tutors.

Of tutors only 38% felt more connected to the community after participating in the SAG program, whereas 62% of workshop participants felt so, as shown in Figure 2. Consistent with this finding was that a majority of workshop respondents also believed that their interactions with other people had increased after SAG participation, compared with only 28.8% of tutors.

The one exception to this pattern of responses was in the reported improvements in the adults’ ability to relate to children. A majority of both workshop and tutor participants reported improved ability to relate to children after their intergenerational experience, as shown in Figure 3.

FIGURE 1. Percent of Adults Reporting Key Cognitive and Social Benefits of Intergenerational Science Learning by Education Level (p values for all comparisons < .001)
These findings show that the group workshop setting resulted in more ISE learning, social interaction and societal benefits for older adults, compared with those in the one-on-one tutoring setting. (It was noted that some of the older adults seemed to automatically drift into the tutorial role, as compared with the co-learner mode. For this reason,
SPRY developed a guide, *Investigating Science With Children*, which provided the adults with suggestions on how to be an effective and supportive learning partner.

One possible explanation for the apparent advantages of the workshop condition is that the social environment can influence learning through mechanisms such as modeling, reinforcement, and establishment of social norms. This is the most likely explanation for the results, given the modest demographic differences.

**Impact as Reported by Children**

- The vast majority of children (79.5%) attending SAG reported at the post-assessment that they liked the session a lot.
- A majority (70.2%) also indicated that they thought they learned a lot from the session.
- Those attending workshops increased knowledge scores significantly from pre- to post-assessment (78.4% vs. 84.7%).
- Those attending tutor sessions had moderately higher post-assessment scores, compared to children attending workshops (89.2% vs. 84.7%).
- Both groups of children (younger and older) gained an average of five percentage points in science knowledge by participating in the workshops.

These findings indicate that the intergenerational ISE co-learning approach was very appealing to children and that children had significant science knowledge gains.

**Impact of the Intergenerational ISE Co-Learning Model for the Intergenerational Field**

- The intergenerational ISE model is effective in both a workshop and tutorial setting; however, there were more positive outcomes in the workshop setting.
- Older adults in workshops reported more ISE learning, social interaction, and societal benefits, compared with older adults in tutorial sessions.
- Both biologically related and unrelated intergenerational pairs benefited equally in the workshop settings.
- Both older adults and children found the intergenerational ISE co-learning model an appealing and “fun” learning environment.
These results show that older adult participants reported important positive changes from intergenerational ISE experiences that reflect benefits for the older adult, the child, the community, and society as a whole.

**IMPLICATIONS FOR INTERGENERATIONAL PRACTICE**

The implication of these findings for other intergenerational practice applications is positive. SPRY’s experience suggests that its intergenerational informal science model pioneered a unique and innovative approach, via the workshop co-learning model, for engaging children and a previously untapped ISE population, older adults, in informal science. This intergenerational approach has demonstrated its potential among older adults and children alike to increase interest in learning about science, to increase knowledge and understanding of science relevancy and to appeal to older adults and children in geographically diverse locations and in varied learning environments.

The model should now be applied to other topics of interest to children and older adults to learn how intergenerational co-learning can be expanded to the benefit of both groups. There is no apparent barrier to applying and extending this co-learning approach in other areas of ISE and beyond. SPRY believes that topics such as health improvement (see Box 2), effective use of technology, safety, civic engagement, and environmental preservation would be excellent examples of topics of mutual interest to youth and older adults that could benefit from intergenerational co-learning.

**IMPLICATIONS FOR INTERNATIONAL PRACTICE SETTINGS**

Intergenerational learning is a growing topic of interest in the international community. Worldwide, traditional definitions of family are changing under the influences of economic and societal upheavals, often signaling alterations in the roles played by older adults and children. While children are becoming adept practitioners of new technologies and electronic communications through school IT programs, their grandparents are setting out on new physical and intellectual adventures, enabled by advancements in health care and their societies’ evolving attitudes about aging. What was once a one-way avenue between teachers and taught, elders to youth, is fast becoming a two-way path,
BOX 2. Heart Healthy Sub-Study

After completion of the principal 3-year component of the SAG project, SPRY conducted a sub-study to test the intergenerational workshop model in a predominantly lower socio-economic and racially and ethnically diverse population. This sub-project was undertaken because of evidence that underserved minorities feel even more inadequate, alienated and uncomfortable with science than the general population (Brickhouse, 1994). It was based on the observation that informal science that is presented within a familiar context is more likely to be accepted (Osborne, 1998). This study was also funded by the National Science Foundation.

Adapting one of the twenty ISE modules used in the main SAG program, the study measured knowledge of and attitudes towards prevention of hypertension. Highly participative workshops were implemented in 2004 in five cities with racially diverse populations: Erie, Pennsylvania, Cincinnati, Ohio, Los Angeles, California, Odenton, Maryland, and Washington, DC.

The majority of the 132 children and 81 adults, who participated in the workshops from racial or ethnic minorities, are African Americans. The children ranged in age from 9-14 years; the adults from 50 to over 70 years of age.

SPRY created manuals for the workshop instructors, detailing how to prepare for and implement the workshops and including worksheets and other materials to be duplicated for the participants.

As measured by comparing the post-tests with the pre-tests, both the children and the seniors had significant knowledge gains after participating in the workshops, as well as increases in participants’ capability to make and understand the value of behavior changes in order to prevent and manage hypertension.

In addition, both adults and children expressed satisfaction with the participatory format of the workshops and the seniors were particularly laudatory about the intergenerational aspects of the experience.

These results demonstrate that the intergenerational approach can be of measurable and significant benefit to public health professionals in conducting health and disease prevention activities and community-based programs in racially and ethnically diverse populations.
with exchanges of ideas and experiences. Also noted is the fact that in both industrialized and non-industrialized societies, there is a rising incidence of grandparents becoming the primary care givers of their grandchildren.

Numerous programs around the world testify to recognition of these trends. The Japan Intergenerational Unity Association (JIUA), founded in 2004, conducts workshops to educate facilitators on intergenerational learning. The Wales Centre for Intergenerational Practice (CCIP), also established in 2004, states as its goals the support of those involved in intergenerational activities, developing understanding of the benefits of intergenerational practice, and influencing decision-makers to incorporate initiatives for intergenerational funding and programs into their budgets. The CCIP is also working to establish a network of disciplines, such as education, gerontology, arts, and law enforcement, for mutual support and exchange of information.

Age Concern Northern Ireland has developed intergenerational school-based programs for students with challenging behavior and community-based programs focusing on subjects such as the environment and anti-social behavior. The Luoshan Community Service Center (CSC) in Shanghai, China, actively engages the elderly with the young in programs such as calligraphy and chess classes, where older adults take on the role of teachers and organizers.

Professor Akpovire Oduaran, head of the Department of Adult Education at the University of Botswana, currently heads the effort to establish the African Network for Intergenerational Relationships, one of the goals of which will be to re-establish these relationships in societies fragmented by the HIV/AIDS pandemic.

Today, there are many new opportunities for older adults to continue to help build active communities, promote citizenship and help address inequalities in society. In doing so, there is a need for older adults to better understand the intergenerational relationships, and how youth in society have different perspectives that may complement rather than clash with views held by older members of society.

The co-learning approach, where each person respects the learning of the other and where the pair learns new information together and experiences a re-framing of their values is also an important method of bringing youth and older adults to better understand each other’s vision of the future, society, and each other.

Traditionally, in nearly all cultures, older adults have been viewed as persons with wisdom and experience, who should receive respect for their knowledge. SPRY’s study on diverse views of aging, Redefining
Retirement: Research Directions for Successful Aging Among America’s Diverse Seniors, showed how older adults in different cultural groups in the U.S. viewed aging differently, from their own specific cultural perspectives. With increased longevity, older people are living longer and have new expectations, including a desire to continue to be intellectually and socially connected to their community, to be productive, and to remain independent and respected.

SPRY’s Science Across the Generations program, which has proven the benefits not only of intergenerational learning but of a co-learning environment, could serve as a prototype for the advancement of many such programs, either for developing co-learning experiences in ISE or in other fields of interest in varied cultural settings.

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