Snail Trails and Science Tales: Inventing Scientific Knowledge

Richard Ponzio, University of California, Davis &
A. Michael Marzolla, Youth Development Advisor, United States

Abstract
In Western culture, people think of scientists as specialists at inventing knowledge of the world and how it works. Scientific knowledge is stories told by scientists. Theories are either compelling and accepted by other scientists and the public, or, if they lack elegance and believability, they are ignored or discarded. The authors assert that children can best communicate their science learning through a variety of communication strategies: written, oral, graphic, and artistic means provide a richness unmatched by standardized tests. Although this article focuses on the situation and needs as found in California and the United States, the Youth Experiences in Science Project and its materials are available through Canadian 4-H programs.

Résumé
Pour les Occidentaux, les scientifiques sont des spécialistes qui inventent les connaissances du monde et en expliquent le fonctionnement. Les connaissances scientifiques, ce sont les récits que nous rapportent les scientifiques. Si les théories exposées sont convaincantes, les autres scientifiques et le public les adoptent; si elles manquent d'élégance ou de crédibilité, elles sont boudées ou rejetées. Les auteurs affirment que les enfants transmettent le mieux leur apprentissage scientifique lorsqu'ils sont exposés à diverses stratégies de communication : les moyens d'expression écrite, orale, graphique et artistique fournissent une richesse inégalée par les tests habituels. Bien que cet article se concentre sur la situation et les besoins actuels en Californie et aux États-Unis, on peut accéder au projet scientifique YES et à la documentation connexe en consultant le Conseil canadien des 4H.

After School Hours as "Prime Time" for Building Science and Environmental Literacy

Why After School Hours?

After the school bell rings dismissing children for the day, many of those children need care while their parents finish work. These children constitute a vulnerable and needy group for continued supervision. The average expense per year for after-school childcare averages the same cost as a year of tuition at the University of California. Even with such a high cost, five times as many California children need childcare than there are available spaces (California Child Care Resource and Referral Network, 2001). There are, in many schools, on site after school childcare programs. In most cases these programs have child safety and custodial care as a primary focus. They also provide programs to engage children and keep them occupied.

In this paper we describe how, as educators, we can do better by encouraging young children's interest in science and by providing activities that allow children to engage in *real-world, hands-on applications and extensions of the academics* that they have been taught (and tested) in school. The Youth Experiences in Science program, that we use as an example throughout our manuscript, is a program that has proven effective for upgrading children's science and environmental literacy. The Youth Experiences in Science program and its activities are constructivist in design and use multiple ways of learning and expressing science literacy and environmental understanding. Youth Experiences in Science was developed by the University of California 4-H Program with sponsorship from the National Science Foundation. Our goal in Youth Experiences in Science was not to have the concepts of science and the scientific thinking skills disappear like melting snow, but rather to have children inquire and use what they learned in science, and to integrate it in their everyday lives, to learn and discover where the snow goes when it melts.

The Unique Opportunities in Community-Based Programs

If one follows a constructivist educational model that views direct experience as being antecedent to learning, the case is made for direct experiences in science. It follows that participants would then work on authentic tasks and projects using their newly acquired skills in new ways. This paradigm fits well with proven pedagogical practices, such as the learning cycle (Guzzetti, Snyder, & Glass, 1992; Lawson, Abraham, & Renner, 1989), and cooperative learning strategies (Covington, 1992; Slavin, 1983) that have been found effective in science instruction and fit current brain development models (Brooks & Brooks, 1993; Caine & Caine, 1991; Sylwester, 1995). Community-based science programs also allow participants to apply their learning to a wide variety of home, neighbourhood, and community situations, in settings such as helping to design and implement recycling programs, raising vegetables in community gardens for senior citizens centers, or helping design family disaster-emergency response plans. These projects encourage youth to solve problems grounded in real-world contexts requiring many kinds of complex problem solving skills suggested by advocates of "outcome-based" education (Spady, 1994). Although the diversity of projects and outcomes poses a major challenge to evaluation, it helps keep participants engaged in service learning applications of their science knowledge. The project-based outcomes also help forge a connection between "school smarts" and "street smarts" and encourage career exploration by tying scientific thinking and problem solving skills learned and applied in community issues significant to the learners.

Much of the literature to assist us is available from the past works of John Dewey and Jean Piaget to contemporary findings of cognitive scientists and brain researchers (Brooks & Brooks, 1993; Caine & Caine, 1991; Sylwester, 1995). Many of the instructional models are available for our use from Socrates to the current research on effective instruction and best education practices.

Why Science and Environmental Literacy?

One need only pick up a daily newspaper to appreciate the demand for technological and scientific literacy. With increasing frequency, voters are asked to pass judgment on issues such as offshore oil drilling, the fate of endangered species, and the commercial uses of genetic engineering. Employers and employees alike are faced with decisions regarding environmental sensitivity in the workplace. The United States Department of Education recently reported that US students scored below the international average on the science portion of the general knowledge assessment and were among the lowest of the 21 countries who participated in the Third International Mathematics and Science Stud testing (National Center for Educational Statistics, 1998). It is increasingly clear that schools cannot do it alone, and therefore one must ask "what is this lack of scientific understanding costing us in terms of our children's ability to understand their natural world?" How can we apply research findings and best practices to increase scientific literacy and environmental awareness for all youth?

Recent Science Education Reform

To address the important demand for scientific literacy, educators have advocated widespread reform in elementary and secondary schools. While calls for reform in science education are not new, the current wave can be distinguished from earlier reforms in several ways. Reforms in the 1970s and 1980s tended to focus on increasing the amount of time students spent on science in their schooling, and on improving access to science education and science careers for female and minority students. Recent attention has been directed to reforming both the content and pedagogy of school science, and maintaining the emphasis on improving access for all Americans to science education and science-based careers. Science education proposes to emphasize the use of scientific thinking processes, the reorganization of science content, and increased attention to presenting applications, of the scientific principles being learned, to social issues in the homes and communities of school-age students. These shifts have fostered new interest in the uses of inquiry-based instruction and "hands-on" and "heads-on" approaches to science teaching and learning.

These approaches are echoed by advocates for environmental education such as Lieberman and Hoody (1998) who stress the importance of project-based and problem-based learning. Simmons (1999) describes strategies for using the environment as a unifying context for learning. They also stress, among other topics, the need to educate young people about systems, interdependence, and integration of disciplines, such as the natural sciences and the humanities.

As we enter the 21st century there is an increasing focus on the educational opportunities afforded in the community. Certainly schools are one piece, but there are others such as after school child-care, youth groups sponsored by community agencies, Boys and Girls clubs, the 4-H Youth Development Program, and other programs offered by institutions such as museums and zoos. There is also opportunity for parent involvement, sometimes through home schooling, other times as volunteers in programs such as 4-H and scouting. One approach, developed by the University of California, specifically to address science literacy of young children in after school childcare, is the Youth Experiences in Science Program.

What is the Youth Experiences in Science [YES] Program?

Youth Experiences in Science is a series of environment-related hands-on, science activities that build key concepts and skills used in science, such as observing, communicating, comparing, questioning, and analyzing. They are also components for developing environmental literacy. Youth Experiences in Science materials have been designed and refined for high interest, participation, and enthusiasm. Significantly, it uses teenage volunteers as teachers. The results are high payoff activities that are designed for implementation at childcare sites are unique and effective ways of learning science. The materials are inquiry-based and they promote active investigating animal behaviour and environmental issues.

Why is it good science? The approach used in the activities is: "let's find out." When we want to learn more about snails or earthworms we have the children observe, communicate, compare, then organize their findings. The children begin to develop an understanding of concepts by using these basic thinking skills. This "doing" is also accompanied by their own independent verification processes. The Youth Experiences in Science activities were carefully built on sound science and environmental education practices. Youth Experiences in Science is good constructivist education because it allows individuals, working alone or in groups, to use their senses and imaginations to manipulate materials and events toward greater understanding. For example, children are able to observe how snails move from place to place, and how they make their living in a garden.

Why is it designed for, and used in, after-school childcare programs? Working with children in local after-school programs has worked well for Youth Experiences in Science because the existing program's administrative and ongoing support structure allows Youth Experiences in Science to focus upon program implementation strategy rather than needing to build infrastructure. In turn, the child-care programs usually are eager to find high quality, engaging activities related to academics. Finally, after-school program directors find Youth Experiences in Science attractive because it taps into an effective source of instruction through the development of an underused group of teachers—teenage youth seeking service learning experiences. Research has shown that teens make excellent teachers, and that the program delivers after-school programs of good science and environmental activities (Murdock, Lee, & Patterson, 2000; Ponzio & Peterson, 1999; Ponzio, Junge, Smith, Manglallan, & Peterson, 2000).

Teens as Teachers

Research findings support the effectiveness of the teens as teachers and point toward their potential as instructors of young children (Murdock, Lee, & Patterson, 2000; Ponzio & Fisher, 1995; Fisher, 1998). Studies also found that children were encouraged in their learning by their contact with teen teachers who were themselves learning about the science materials and processes. Analysis of the data provided five distinct reasons why teenagers are effective teachers of science for young children:

- Teenagers are apt to do science activities themselves;
- Teens relate well with children;
- Teens are valued by children as role models;
- Teens are positive, confident, optimistic, and certain; and
- Teens are less apt to restrain children (Ponzio & Peterson, 1999; Ponzio, et al., 2000).

The Youth Experiences in Science program is unique in that it uses an existing, highly-motivated group of people: teenage 4-H members. These teachers show high energy, involvement, and initiative. Our studies show that they are unusually effective teachers of the children, because the teens are novel, link more readily with the kids, get involved in the activities themselves, and provide steady but unusually positive leadership (Ponzio & Peterson, 1999).

The setting is a remarkably safe one, because adults provide the supervision of the children, and specially-prepared adults provide support for the teen teachers. Each population is allowed to explore in their roles by using newly-learned inquiry skills to explore and learn about environmental issues.

Not only are the teen teachers effective with the target population of 5-9 year old children, the experience is a rewarding and productive one for the teens. In the short term, teens find a challenging activity, one that is, for most, a satisfying addition to their prior experiences in learning science in school. The teens' study and preparation, in order to teach science and environmental literacy to the younger children, is effective in helping them consolidate their own understanding of science and the environment. There are additional long term payoffs for the teens, like the chance to explore teaching as a future occupation. The training of teens to teach this curriculum is done in 10 hours, (two five-hour sessions). This is a remarkably economical training procedure.

Youth Experiences in Science Applications in Studying and Involving the Family in Environmental Issues

Youth Experiences in Science is "family friendly." Program materials and activities include take-home components such as loaner backpacks, and parent nights. These features support the environmental literacy—by taking what the children, teens, or parents learn about animal interactions, involvement in watershed restoration activities, and other direct experiences, then fostering reflections based on observation. We have found that this participation "spreads" and they become involved in observing and comparing other animals, or local environments and developing new project-based inquiry activities. Interviews and focus groups indicate that the program has supported student and parent cooperation around additional learning.

Using Youth Experiences in Science to Reach Underserved Communities

Researchers who have surveyed Latino communities have found that, contrary to popular belief, the majority of recent Latino immigrants are concerned about environmental issues, and that these issues can best be addressed by community involvement (Schultz & Unipan, 2000).

Experience with the program from its beginnings to the present has shown a significant contribution to previously underserved populations in science. For example, the opportunities for young women have been impressive. The hands-on nature of Youth Experiences in Science gives limited English speakers much opportunity for participation and learning. Spanish versions of Youth Experiences in Science have increased the utility of these materials with Spanish-speaking audiences (Ponzio & Peterson, 1999).

Projects with similar design characteristics, such as being project-based and using cross-age teaching, have been successful with youth from underrepresented populations, for example, in Santa Barbara County, California (Santa Barbara County Education Office, 2001). Various 4-H Youth Development Programs have been developed to interest and engage Santa Barbara's Latino youth and their families in science activities and environmental issues. The Youth Experiences in Science curriculum has proven to be a valuable tool for staff, volunteers, and teens involved in other projects. The following are brief descriptions of three such projects:

The GreenNet Project. The Neighborhood GreenNet Project or *La Red Verde de la Vecindario* is a collaborative project aimed at engaging low-income families and their children, who are living in subsidized housing complexes in the city of Santa Barbara, in small horticultural (green) business startups that utilize cutting-edge computer technology. Participants learn how to access web-based information, use computer-based organizing and planning tools, and networking capabilities, and they have access to a local high school's greenhouse and garden facility. GreenNet is coordinated by the Housing Authority of the City of Santa Barbara (HACSB) and the University of California 4-H Youth Development Program. Latino teens have served as paid project staff, activity leaders, website designers, and assistant coordinators. Teen volunteers who are performing required community service often assist the teen staff. They in turn have helped train the project's young participants through hands-on, green projects that utilize the Youth Experiences in Science curriculum as a context for launching their projects. Since 1998, GreenNet has engaged over 550 Latino youth and 350 Latino families. Many of the teen staff who have participated in GreenNet have gone on to pursue a college education, and several have elected to major in science or a science-related field. Likewise, youth participants in GreenNet have also developed various community-based environmental projects. These have included the development of two native-plant nurseries for local restoration projects.

Fun in the Sun. Fun In The Sun is a collaborative educational summer day camp for children from very low-income families in Santa Barbara. The collaborators include Girls Inc. (formerly the Girl's Club), and 4-H. The camp serves young people, ages 6-11. It is a summer camp and is staffed by Latino undergraduates from the University of California at Santa Barbara. The Youth Experiences in Science curriculum is used extensively as part of the Fun in the Sun curriculum. Staff have found it to be user-friendly and very adaptable. They also report that the kids enjoy the learning activities.

Agua Pura (Pure Water). began as a partnership of the University of Wisconsin Cooperative Extension's "Give Water A Hand," Santa Barbara County Cooperative Extension 4-H Youth Development Program, and Santa Barbara City College to bring together youth education leaders who work with Latino youth on watershed education and stewardship issues. The project featured a Leadership Institute for formal and nonformal educators. The Institute featured resources from Give Water A Hand, Global Rivers Environmental Education Network (GREEN), Adopt-A-Watershed, California Aquatic Science Education Consortium (CASEC), and the 4-H Science Experiences and Resources for Informal Education Settings (SERIES) "From Ridges to Rivers" as the foundation for improving understanding of how to involve local Latino youth in watershed protection.

California Aquatic Science Education Consortium and Science Experiences and Resources for Informal Education Settings are both sister projects of Youth Experiences in Science. Both are science-based curriculum packages designed for use in nonformal settings. They incorporate hands-on science activities that build key concepts and skills in science and environmental literacy. The Science Experiences and Resources for Informal Education Settings and California Aquatic Science Education Consortium curricula are geared to young people, ages 10-15. Like Youth Experiences in Science, the Science Experiences and Resources for Informal Education Settings curriculum were designed to be delivered by teens.

The Leadership Institute focused on strategies for involving the Latino community and strategies for adapting resources to meet their needs and interests. Agua Pura continues to successfully involve mainly Latino youth and youth leaders throughout Santa Barbara County by presenting workshops, camp programs, and after-school activities. The Institute has provided a variety of leadership opportunities for young Latino people. The project has published a guide that documents the process used to develop and implement successful strategies for involving Latino communities in watershed education (Andrews & Marzolla, 2000).

Recent Advances in Research on Brain Functioning and Learning

During the past several decades researchers have found evidence to support using constructivist approaches to instruction, and approaches that use multiple techniques and strategies (Jones, Carter, & Rua, 1999). This includes the pioneering work by Howard Gardner (1983, 1991), elaborating the multiple intelligences used by individuals when they learn and express their knowledge and information. Anderson and Stewart (1997) suggest that neuro-cognitive instruction has several common threads such as:

- Encourages learner autonomy, initiative and leadership.
- Asks participants to elaborate on their responses and theories.
- Provides "wait time" for learners to answer questions.
- Encourages cooperative work and interactions among all involved.
- Encourages participants to reflect on experiences and predict future outcomes.
- Makes frequent use of open-ended questions.
- Encourages alternative conceptions of problem solutions/strategies.
- Asks the participants to articulate their theories and concepts before the group leader presents his or her opinion.

These attributes of the Youth Experiences in Science Program and its implementation fit well with educational practices as they relate to current learning theory.

Youth Experiences in Science Characteristics Related to Brain-Based Pedagogy & Community Development

Designing an educational mosaic for science education includes complementary pieces that represent a common goal or vision. This mosiac might be described as having many paths to the goal of science and environmental literacy. Programs in science and environmental education, based upon neuro-cognitive research, share important features, regardless of whether they are found in schools, museums, or theme parks. Although the venue may vary, each program can reinforce the development of science literacy by applying principles of learning, scientific investigation, and participant involvement that are common to each. Perhaps the most durable common element of effective science instruction that fits well with brain development research, is the use of the learning cycle (Karplus, et al., 1980; Lawson, Abraham, & Renner, 1989; Marek & Cavallo, 1997). This model has shown consistent learning gains in K-12 educational settings (Guzzetti, Snyder, & Glass, 1992). The learning cycle is made up of three distinct segments. In general each activity begins with an exploration segment during which students manipulate materials, encounter some interesting or puzzling phenomenon, and attempt to observe and understand the phenomenon by changing something in the situation and noticing the effects. In the second segment, concept development, the participants and their leader engage in a discussion of observations made, and collectively develop a theory, concept, or hypothesis that explains what they noticed in their initial explorations. Once some of these key ideas are developed as concepts or predictions and articulated through discussion, the third segment begins: The participants discuss and plan ways to apply the concept or concepts in a personally meaningful context. This general structure of exploration, followed by concept development, followed by concept application, is the primary template for brain-based, constructivist curricula. Work by Guzzetti, Snyder, and Glass (1992) and others have shown learning cycle effectiveness relating to a variety of outcomes including more positive attitude towards, and interest in, science, and improved student understanding of science. Additional effective pedagogical practices include:

- Use of activities that are participatory (hands-on) and inquiry-based (heads-on) with opportunities for participant reflection;
- Use of questioning strategies that engage participants in making sense of what was observed; constructing mental models or theories are also important;
- Use of scientific thinking processes (observing, communicating, comparing, organizing, relating/experimenting, inferring, and applying) found in virtually all school science programs;
- Activities are designed so participants engage in cooperative learning; learning tasks, and service learning projects can be structured in a way that requires groups work together;

- Authentic assessment opportunities such as the construction of self-managed portfolios representing the participant's work; and
- Incorporating a cross-age instructional strategy wherein older youth assist young learners with exploration, concept development and concept application to promote a more profound understanding of a topic.

The Place of Community-Based Learning Opportunities in Science

Finding the money, time, or space in the regular school curriculum for increasing science and environmental instruction related to real life or careers in science has, in general, met with little success and has further separated science, scientific thinking, and the pursuit of environment or science-based careers from most students' aspirations.

Work by researchers including Howard Gardner (1983, 1991) and Siegel and Shaughnessy (1994), addresses the issue of students' lack of understanding and the inability of learners to take knowledge, skills, and other apparent attainments, and apply them successfully in new situations. The literature on multiple intelligences suggests multiple paths toward a goal, including using involvement in projects, either projects assigned to students or projects that they have helped design. The results are multiple outcomes as expressions of understanding, including production of student portfolios.

Each of these factors—for example, changes in the content and pedagogy of science and environmental education, stronger linkages between learning and service, and dissatisfaction with traditional science education—has contributed to the current wave of reform in classroom science instruction and, inevitably, to calls for reform in training of science teachers. These shifts have fostered new interest in "constructivist" approaches to teaching, and an interest in authentic tasks and authentic assessment.

Additional impetus for entrepreneurial applications of learning to real-world problem solving can be found in the rekindled interest in service learning, which is defined as the blending of both service and learning in such a way that each is enriched by the other. Along the lines of developing career awareness through hands-on learning experiences, former United States Secretary of Labor, Robert Reich (1983, 1991), argues that America is no longer dominated by a production-line economy but is rapidly moving toward a dynamic, entrepreneurial, global economy, and that our schools should provide experiences for learners that are dynamic and entrepreneurial by design. In part, this notion suggests that educational experiences should include more activities that allow students to work cooperatively on the heuristics of problem finding, problem framing, and problem-solving as the core aspects of learning and citizenship.

Conclusion

The experiences garnered from developing and applying the Youth Experiences in Science program materials (and the related Science Experiences and Resources for Informal Education Settings and California Aquatic Science Education Consortium materials) have provided us with valuable examples of the successful integration and application of progressive learning theories in nonformal settings. The program has provided non-formal and formal educators, and curriculum developers, with a proven model that has effectively engaged large and diverse audiences of children, teens, and parents in enhancing their science and environmental literacy. By having these learning experiences take place in their own neighbourhoods, the participants often go on to apply what they have learned through community service, from beach clean-ups, and survey projects, to recycling programs, to park planning, and tree planting. Programs like this one, and other cross-age experiences, provide participants with an opportunity to teach a little, and learn a lot about science and their environment. Such after-school, community-based projects provide children, youth, and adults with an opportunity to make a difference—a difference worth making.

Notes on Contributors

Richard Ponzio, University of California Cooperative Extension Specialist in science education, is a faculty member in the Department of Human and Community Development at UC Davis. He received his Doctorate in science education from the University of California, Berkeley. He has directed national science projects devoted to helping children realize that they are, by nature, scientists and artists.

A. Michael Marzolla is a 4-H Youth Development Advisor with the University of California Cooperative Extension in Santa Barbara County. With over twenty-five years experience as a nonformal educator, he has worked in Africa and Latin America. He holds a Masters in Education, specializing in non-formal education, from the University of Massachusetts' Center for International Education.

References

Andrews, E. & Marzolla, A.M. (2000). *Agua pura: A leadership Institute planning manual for Latino communities*. Wisconsin: Environmental Resources Center, University of Wisconsin Cooperative Extension.

Anderson, O. & Stewart, J. (1997). A neurocognitive perspective on current learning theory and science instructional strategies. *Science Education*, *81*(1).

Brooks, J.G. & Brooks, M. (1993). *In search of understanding: The case for constructivist classrooms*. Alexandria, VA: The Association for Supervision and Curriculum Development.

California Child Care Resource and Referral Network (2001). *2001 California Child Care Portfolio*. Sacramento, CA.

Caine, R. & Caine, G. (1991). *Making connections: Teaching and the human brain*. Alexandria, VA: The Association for Supervision and Curriculum Development.

Covington, M. (1992). *Making the grade: A self-worth perspective on motivation and school reform*. New York: Cambridge University Press.

Fisher, C. (1998). 4-H SERIES as an educational catalyst. In R. Ponzio & C. Fisher (Eds.), *The joy of sciencing* (pp. 73-99). San Francisco, CA: Caddo Gap Press.

Gardner, H. (1983). *Frames of mind: The theory of multiple intelligences*. New York: Basic Books.

Gardner, H. (1991). *The unschooled mind: How children think and how schools should teach*. New York: Basic Books.

Guzzetti, B., Snyder, T., & Glass, G. (1992). Promoting conceptual change in science: Can texts be used effectively? *Journal of Reading*, *35*, 542-649.

Jones, G. Carter, G., & Rua, M. (1999). Children's concepts: Tools for transforming science teachers' knowledge. *Science Education*, *83*(5).

Karplus, R., Lawson, A., Wollman, W., Appel, M., Bernoff, R., Howe, A., Rusch, J., & Sullivan, F. (1980). *Science teaching and the development of reasoning* (4th edition). Berkeley, CA: The Regents of the University of California.

Lawson, A., Abraham, M., & Renner, J. (1989). *A theory of instruction: Using the learning cycle to teach science concepts and thinking skills*. Monograph, Number One, National Association for Research in Science Teaching.

Lieberman, G. & Hoody, L. (1998). *Closing the Achievement Gap: Using the environment as an integrating context for learning*. State Education and Environment Roundtable, Science Wizards, Poway: California.

Mareck, E. & Cavallo, A. (1997). *The learning cycle: Elementary school science and beyond*. Portsmouth, NH: Heinemann.

Murdock, S., Lee, F., & Patterson, C. (2000). Teenagers as cross-age teachers: Lessons from the field. In M. Braverman, R. Carlos, & S. Stanley (Eds.), *Youth development programming: Reviews and case studies from the University of California* (pp. 13-31). Oakland, CA: University of California Press.

National Center for Educational Statistics. (1998). *Pursuing excellence: Initial findings from the third international mathematics and science stud*. Washington, DC: U.S. Department of Education.

Ponzio, R. & Fisher, C. (1995). Introducing prospective teachers to contemporary views of teaching and learning science: The science and youth project. In M.J. O'Hair & S.J. Odell (Eds.), *Educating teachers for leadership and change* (pp. 257-284). Thousand Oaks, CA: Corwin Press.

Ponzio R. & Peterson, K. (1999). Adolescents as effective instructors of child science: Participant perceptions. *Journal of Research and Development in Education*, *33*(1) 36-45.

Ponzio, R., Junge, S., Smith, M., Manglallan, S., & Peterson, K. (2000). 4-H Teens as science teachers of children. In M. Braverman, R. Carlos, & S. Stanley (Eds.), *Youth development programming: Reviews and case studies from the University of California* (pp. 75-91). Oakland, CA: University of California Press.

Reich, R. (1983). *The next American frontier: A provocative program for economic renewal*. New York: Penguin Books.

Reich, R. (1991). *The work of nations: Preparing ourselves for 21st century capitalism*. New York: Knopf.

Santa Barbara County Education Office. (2001). *2000-2001, CEBEDS Enrollment by ethnic group*. On-line at: http://www.sbceo.k12.ca.us/districts/cbeds/OOcbeds (pp. 1-4, ethnic.pdf). Santa Barbara, California.

Schultz, P. & Unipan, J. (2000). Aculturation and ecological worldview among Latino Americans. *Journal of Environmental Education*, *31*(2), 22-27.

Simmons, D., Archie, M., Mann, L., Vymteal-Taylor, M., Berkowitz, A., Bedell, T., Braus, J., Holmes, G., Paden, M., Raze, R., Spence, T., & Weiser, B. (1999) *Excellence in EE-guidelines for learning (K-12).* NAAEE: Rock Spring, Georgia.

Siegel, J. & Shaughnessy, M. (1994). Educating for understanding: An interview with Howard Gardner. *Phi Delta Kappan*, *75*(7), 563-566.

Slavin, R. (1983). *Cooperative learning*. New York: Longman.

Spady, W. (1994). Choosing outcomes of significance. *Educational Leadership*, *51*(6).

Sylwester, R. (1995). *A celebration of neurons: An educator's guide to the brain*. Alexandria, VA: The Association for Supervision and Curriculum Development.