PLENARY SESSION III – FOUNDATIONS OF URBAN ECOSYSTEM EDUCATION FROM EDUCATION THEORY AND PRACTICE

Psychological and ecological perspectives on the development of systems thinking

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We explored the development of systems thinking along two parallel tracks. In one we examined how the scientific community has developed knowledge about complex ecological systems. Our focus was on the processes, not the products of scientists' knowledge development. We traced the genesis and evolution of several landmark ecosystem models to identify the core characteristics of the systems thinking of the ecologists who developed the models. We also identified several types of social structures that have facilitated the development of scientists' knowledge about ecosystems.

We also examined the psychological and educational research literatures to develop a conception of systems thinking appropriate for precollege students. We converged on a theory of learning known in the literature as "acquired modularity" as a useful heuristic framework for defining and developing learners' capacities for systems thinking. The basic notion of acquired modularity is that people can learn to activate a whole suite (or "module") of skills, knowledge, goals, and attitudes as a cohesive unit when the need for the module is contextually triggered. For instance, when students' context is a small group meeting to choose the focus of a science project, they would activate a different module than when their context is a study hall preceding a final science exam. When students' task is to understand something about the structure and function of an urban ecosystem for instance, they would activate a task-specific module which we call a systems thinking module.

We specified potential components of a systems thinking module by comparing our list of the elements of scientists' systems thinking with the core elements of contextual learning modules that have been proposed by educational theorists. Despite the differences between doing professional science and doing school science, we found a good deal of overlap in the kinds of thinking that it takes to do both successfully. We also identified several key aspects of scientists' thinking that are underemphasized in schools (e.g., psychosocial dimensions), as well as aspects of scientists' thinking that could perhaps be enhanced with explicit attention to the features of effective thinking specified by psychologists (e.g., metacognition, such as contemplating the dynamics of knowledge development).

The integrated list of components of a systems thinking module resulting from our comparisons includes:

Declarative Knowledge: (e.g., knowledge about system properties, specific systems, what models are and can do, the nature of science and of learning science)
Reasoning Abilities: (e.g., logical, dialogical, integrative, and regulatory skills that enable systems thinking)
Problem Models (e.g., rules for recognizing situations that require systems thinking, and expectations for what will be entailed)
Goal Structures (e.g., intentions, motivations, and dispositions to use systems thinking)

Identity (e.g., view of oneself as an active thinker)
Affect (e.g., emotions associated with engaging in systems thinking)
Codes of conduct (e.g., roles and relationships, norms and expectations, rights and obligations, and standards for oneself and others who are participating in the systems learning context)

Finally, we examined the issue of how systems thinking modules might develop in learners. We posed four questions that framed a review of relevant literature, which in turn led to the generation of specific questions for future research on systems thinking. The initial questions were:

- Does conceptual understanding of urban systems build up piecemeal from component subconcepts (e.g., principles of the conservation of matter), or is the development of understanding more dependent on general cognitive frameworks, such as understanding the difference between things and processes, or having schematic models for different patterns of complex causality?

- What are the developmental patterns or constraints in the use of certain reasoning skills that are integral to systems thinking?

- What is the potential role of epistemological frameworks (e.g., knowledge about the nature of knowledge building) in systems thinking, and how do these develop?

- What is the role of experience in the development of systems thinking modules?

We concluded that an educational imperative for fostering the development of students' systems thinking capacities is that schools must take seriously the fact that systems thinking requires a suite of knowledge, abilities, and attitudes, and that some kinds of task and social contexts can provide better opportunities than others for their integrated development. Treating knowledge, abilities, and attitudes as separate learning outcomes is an example of linear thinking rather than of the kind of systems thinking that educators themselves need to employ.

In summary, we have begun to develop a conception of systems thinking that applies not only to academic knowledge and abilities, but also to everyday thinking, learning, and acting in one's local environment. Thus, we interpret broadly the word "understanding" in the title of this conference to encompass academic knowledge, identity development, mindful action, and ongoing learning. Systems thinking is a valuable educational goal because it can enrich the lives of learners in ways that will be meaningful to them as they tackle all manner of complex problems, not solely because it is good for society to have citizens who can think systemically. Whether or not sophisticated systems thinking and understanding are prerequisites for individuals to engage in environmental stewardship, either directly or through their choices at the polls, is an open question.

Applying research on teaching and learning to improving ecological literacy: Implications of Project 2061 science literacy reform tools

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Introduction. Research on learning and teaching informs the development of Project 2061 print and electronic reform tools. The tools, in turn, summarize and apply research to make it useful to other reform efforts. This overview describes the role of research into students' understanding of science in Project 2061 R&D efforts and suggests how tools based on research can be used by reformers intent on helping students learn important ideas in ecology.

Defining adult literacy in ecology. *Science for All Americans* (1989) includes an understanding of ecosystems in its science literacy recommendations. Important ideas for high school graduates to know about ecosystems are found in Chapter 5: The Living Environment (sections Diversity of Life, Interdependence of Life, and Flow of Matter and Energy). For example, the section Flow of Matter and Energy begins by summarizing the link between living and physical systems:

> However complex the workings of living organisms, they share with all other natural systems the same physical principles of the conservation and transformation of matter and energy. Over long spans of time, matter and energy are transformed among living things, and between them and the physical environment. In these grand-scale cycles, the total amount of matter and energy remains constant, even though their form and location undergo continual change.

Subsequent paragraphs provide additional detail about the successive transformations of sun energy, recycling of elements, storage of matter and energy in fossil fuels, and factors constraining ecosystem productivity. The many scientists involved in drafting the adult science literacy recommendations considered these ideas to be among the most important for making sense out of the world and to serve as a lasting foundation on which to build more knowledge over a lifetime.

Steps toward ecological literacy. *Benchmarks for Science Literacy* (1993) describes appropriate steps towards science literacy for students in grades K-2, 3-5, 6-8, and 9-12. (Similar recommendations are found in the *National Science Education Standards*, 1996) For example, the idea to be learned by the end of grade 12 that

> The chemical elements that make up the molecules of living things pass through food webs and are combined and recombined in different ways. At each link in a food web, some energy is stored in newly made structures but much is dissipated into the environment as heat. Continual input of energy from sunlight keeps the process going. (5E9-12#3)

can start in grades K-2 with the idea that living things have needs; develop further in grades 3-5 with the idea that food, coming ultimately from plants, provides energy and materials for growth and repair; and move in grades 6-8 to the idea that, as in physical systems, matter and energy are transformed in living systems.

Research on how students learn science ideas has informed the substance and grade level placement of benchmarks. (*Benchmarks*, Chapter 15). Most research studies report difficulties that persist after traditional instruction. For example, research on student understanding of ecosystems reveals that students view matter as being created or destroyed, rather than as being transformed. Students who do see matter as being transformed view it as being transformed into energy rather than simpler substances. Students also view plants as taking in food from the environment, rather than as taking in raw materials that they convert to food.

In writing *Benchmarks*, reports that students do not understand particular ideas after traditional instruction led to a) stating less sophisticated precursors of a benchmark idea, b) adding prerequisite ideas, and c) moving benchmarks to higher grade levels than where they are currently taught.

Connections among ecological literacy steps. The same research base also supports the development of the *Atlas of Science Literacy* (in preparation), which presents "strand maps" that diagram the developmental progression of benchmark ideas. For example, the strand map "Flow of Matter and Energy in Ecosystems" shows the contribution of ideas from life and physical science to understanding the flow of matter and energy in ecosystems. It reveals important precursors to the grades 6-8 ideas of matter and energy transformation in living systems—e.g., ideas about the conservation of matter and energy transformation in physical systems and precursors to them like "air is a substance" (without which students will have difficulty seeing how the mass of a tree could have come from carbon dioxide in the air).

Curriculum materials to support ecological literacy. Project 2061, in collaboration with cognitive researchers, K-12 teachers, scientists, and materials developers, has developed and field-tested a rigorous procedure for evaluating the quality of curriculum materials. (Roseman, Kesidou, and Stern, 1996; *Resources for Science Literacy: Curriculum Materials*, in preparation). The evaluation carefully examines how well a material's content aligns with ideas in specific benchmarks and how well the instructional strategies in text and teacher's guide can support student learning of those specific ideas. Judgments about content quality are based on accuracy, fidelity to the substance of benchmark ideas, and coherence (such as whether or not ecosystem ideas are connected to ideas in systems thinking). Judgments about instructional quality are based on meeting 25 specific criteria, that are organized into 7 categories. Criteria for judging instructional quality are based on learning research and the craft knowledge of experienced teachers and have been field-tested to ensure that they can be reliably applied to a variety of curriculum materials. For example, within the category "Taking Account of Student Ideas," criteria examine how well the materials develop and build on prerequisite ideas (such as those represented on the ecosystem strand map), alert to and explicitly address commonly held student ideas reported in the research literature (such as the student difficulties described above), and provide specific questions and tasks to identify ideas unique to particular students (which can be adapted from questions used in research studies). Criteria within the category "Engaging Students with Phenomena" probe whether materials include vivid experiences with phenomena that make the scientific ideas plausible and are explicitly linked to them.

Conclusion. There are obvious implications of the Project 2061 tools for reform of curriculum and instruction aimed at helping students achieve ecological literacy. *Science for All Americans* and *Benchmarks* can guide curriculum designers in selection of core learning goals. *Benchmarks* and *Resources* can point to important learning research relevant to instructional design. *Atlas* strand maps can illuminate prerequisites and other connections and *Resources* can provide specifications for designing new materials and improving teaching. Lastly, the set of tools can provide insights for new research directions.

Cities for children and children for cities: Learning to know and care about urban ecosystems

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In considering the subject of children in the city, a first observation is that children are an important element of the urban ecosystem. Depending on the demographic structure of their society, young people under 18 constitute from approximately a quarter to a half of urban populations. The urban ecosystem is not something independent of them--not something for them to learn about as something outside of themselves. Despite our 20th century revolutions in communications, cities remain in many ways cradles of civilization: repositories of great collections of the world's heritage of art and learning; centers for contemporary innovation in the arts, sciences, politics, and business; palimpsests of successive ages of building, decay, and reconstruction; home to diverse living cultures; and crossing points of trade and transportation that usually exist at locations of special geographic and ecological significance. If we envision sustainable civilizations that balance human ingenuity and ambition, social justice, and the integrity of regional and planetary ecosystems, cities must be central to the realization of this vision, and children within cities must be central too. Sustainability is about the obligations of the present to the future, and children are society's bridge to the future, who must not only learn to care for the earth but also for the cultural heritage and social diversity that cities harbor. Therefore Agenda 21 of the Earth Summit and the Habitat Agenda of Habitat II identified children and youth as major actors whose interests and energies must be involved in participatory processes of development and environmental protection.

What kind of cradles are cities for the young who grow up in them, in terms of meeting their basic needs and preparing them for these responsibilities? On balance, most cities are not doing well. Average per capita incomes in urban areas mask great disparities in family incomes. The phenomena of street children and other children in especially difficult circumstances are visible evidence of the extreme hardships that some urban children face. It is also important to consider the impact of what UNICEF has called "new deprivations": a diminishing fabric of social support for children within the family and community; decreasing opportunities for socialization; lack of opportunities to consolidate self-worth in the broader societal sphere; experiences of marginalization and uncertainty about the future; and poorly planned urban environments. According to Growing Up in Cities, a UNESCO project that involves low-income 10 to 15-year-olds in evaluating and improving their local environments, young people themselves are highly responsive to these community qualities. Where these deprivations exist, participants express high levels of alienation. They express satisfaction with where they live, and a desire to raise their own children in the same place, when their communities provide them with a sense of social integration, a range of interesting activity settings, safety and freedom of movement, peer gathering places under their own control, engaging green spaces, and a positive, cohesive community identity. According to the Child Friendly Cities effort of UNICEF, summarized in the book *Cities for Children*, even resource-poor municipal governments can do much to move conditions for children in this direction.

These observations relate to how cities serve children's basic physical and social needs so that they can enjoy their life as children and grow into healthy adults. It concerns children as recipients of care or neglect. The other side of children's part in the urban system concerns their roles as agents. What do children from different backgrounds know about their cities? What can they do to help in protecting or restoring social and ecological integrity? Research on children's cognitive development, including development of spatial cognition and systems thinking, shows that they need extensive direct experience and interaction with the world in order to form increasingly accurate and integrated conceptual systems. Research into the development of care for the environment and commitment to protect it also suggest the importance of bonds with special childhood and adolescent places, and older role models who confirm these places' value.

But opportunities for extensive direct urban experience are at risk. Fear of crime and cars are causing most urban parents to confine their children to a narrow range of free movement: if they allow any free movement at all. Tightly programmed child and family schedules, and the rule of television and other indoor media, has had the same effect. Histories of children's urban movement from early in this century show sharply reduced areas of daily use and exploration. It is also important to consider not only how far children can travel, but the density of experiences available to them within their local range. Urban sprawl and its decentralization of activities and services has thinned opportunities for experience in this sense. Then there is the phenomenon of increasing geographic segregation by race and class, diminishing opportunities for diverse social and cultural experiences. To this list can be added the invisibility of many urban operations and natural flows and most urban management decision-making.

Under these conditions, how can cities do better for their children and how can children gain more chances to know, care about, and care for their cities? Research on children in cities indicates that it cannot be assumed that conditions will improve without a deliberate, coordinated effort to involve all sectors of city government and other urban institutions.

According to the *Cities for Children* guidebook by UNICEF, one of the first steps needs to be the creation of a local plan of action for children that brings municipal plans into compliance with the Convention on the Rights of the Child. Another structural means is the establishment of a child advocate with real powers within every municipal government. Young people also need to be involved in local action plans, as outlined in the Growing Up in Cities manual, *Creating Better Cities with Children and Youth*, and a Planning Aid and Children's Society report, *Changing Places*. Urban studies centers, run within schools or community centers, can turn the city itself into a learning resource. The schoolyard habitat movement, which seeks to recreate local ecosystems on school grounds, makes elements of the city's natural system part of everyday play and learning. The urban gardening movement offers safe, supervised spaces for children as well as adults. Major institutions such as museums, botanical gardens, and zoos can develop on-site and out-reach programs to reach children and families from all ethnic backgrounds and social classes, to promote learning about local as well as distant ecosystems and cultures. Many good ideas from the community development era of the 1960s and 1970s, in terms of increasing young people's access to public transportation and making city infrastructure visible, remain to be realized. Under the banner of "Child-Friendly Networks" that bring together people from government, education, nonprofit organizations, community-based organizations, large city institutions, and private businesses and professions, it is possible to plan with and for children to improve their present and future conditions and to help them grow into roles of responsibility based on an understanding of how cities' natural and social systems work, and how they can work for the better.

Teaching system thinking: A model from Israel

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Assuming the importance of understanding our cities as ecosystems raises three fundamental questions that have to be dealt with: a)What do we mean by 'Urban Ecosystems'? b)What key concepts are required for such knowledge construction and understanding? and c)How do we foster this understanding, in both teachers and students?

a) Urban ecosystems signify the shift from the study of natural environments, to human ones. In terms of their components, they are mainly human-based, their variables, in addition to energy and materials being knowledge or money. Their goals are to supply goods and services to their human inhabitants, in order to sustain them (Figure 1). As compared to natural ecosystems, where man's role was understood in terms of 'management' namely, adapting the flow of energy, water or materials to his needs, man is acknowledged as a sole part of urban ecosystem and not an outside intervener.

b) Key concepts of urban ecosystems consist of system concepts, such as resources, flow-chains, controllers, feedback loops, etc.; first and second order cybernetics; as well as concepts representing unique aspects of human systems, economical, technological, social, cultural, etc.

c) Urban ecosystems today, though aiming towards the well being of man, are faced with severe problems, that stem from life in modern society, such as inequality, child abuse, pollution, isolation and loneliness, etc. To cope with such environmental and social problems, 'wise management' is required, namely, the ability to make decisions that ensure sustainable solutions for human welfare.

Environmental education (EE) and its later version STS (Science Technology in Society), actually manifest these goals, calling for environmental and social literacy. In other words, for raising the sensitivity and awareness of citizens towards authentic problems and taking responsibility towards their resolution. Yet, their recorded achievement indicated a heightened environmental awareness, but failure with respect to students' high order thinking (such as system or ecological thinking) which we regard as prerequisite for making decisions and taking responsibility for future action.

It seems that in Israel as elsewhere, both EE and STS are based on the conventional conception of humans as a guardian of 'ecological systems'. Man, according to this paradigm, is conceived as subject, like all other components of the ecosystem. The researcher, on the other hand, the one who constructed the model is seen as an outsider, who bears no relations to the inhabitants of the study. In terms of the students, while metacognitively, they are *active learners*, in the sense of constructing a model that triggers their active learning; ontologically, they are outsiders (Figure 2).

Such models are based on a 'first order cybernetics' conception. Characterized by feedback loops of control, they are to be found mainly in engineering systems or organizational management studies. Cybernetic concepts are used, yet the learning approach is conventional and positivistic-oriented, where knowledge is regarded as an objective, neutral external entity, that is transferable by 'expert' to novices.

We suggest an alternative model of human-environment relationship for urban ecosystems, in which man as learner or inquirer, is no more a neutral outsider, but is highly interconnected. Accordingly, our curricular units focus on authentic environmental or social problems, which become their main agenda, while their inquiry form a new kind of pedagogy. Involvement in problem solving processes that do not lead to one correct answer entails also ethical deliberations, and responsibility for value judgments (Figure 3).

This is what we mean by 'second order cybernetics', which is the basic conception underlying our model of 'Ecological education'. It positions humans both as insiders and outsiders. As insider, man is actively interconnected with the other components of the system. As outsider, he is self reflective, accepting responsibility for his observations and interpretations, for the way he constructs his system of knowing. In other words, humans *aware* of this relationship are thus able to conceptualize it into a model, and be responsible for changing (or preserving) their system.

To illustrate how such pedagogy is put into practice, a curriculum unit, developed specifically for teachers or student teachers, will be presented. Thereby the learners are enhanced to construct models of their urban ecosystem, which reflect their priorities and value judgments, shaping at the same time, their relationship with their reality (Figure 3).

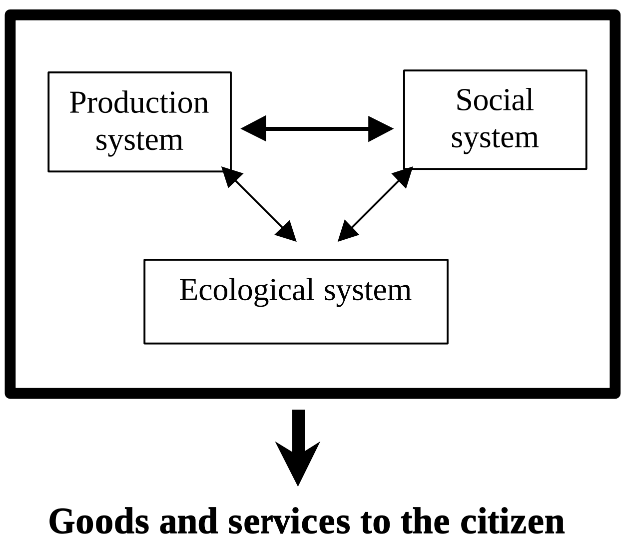

Figure 1: An urban ecosystem

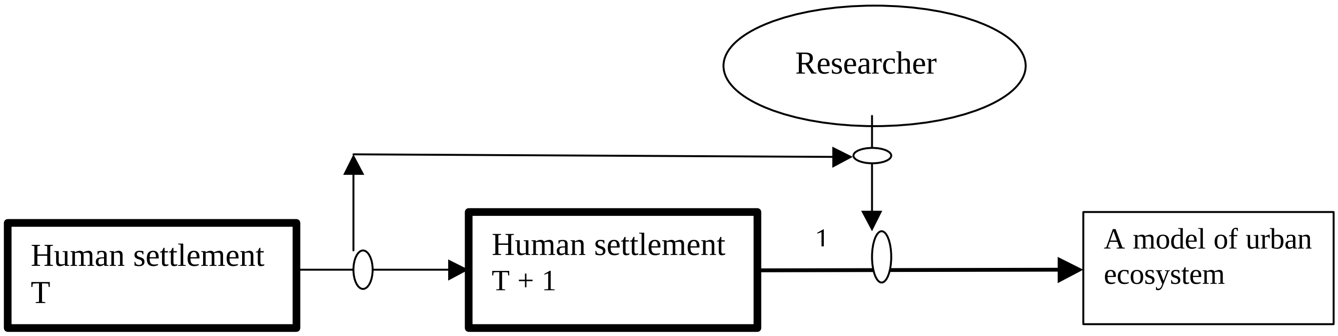

Figure 2: First order cybernetics: man as an outsider builds an urban ecosystem model of a human settlement

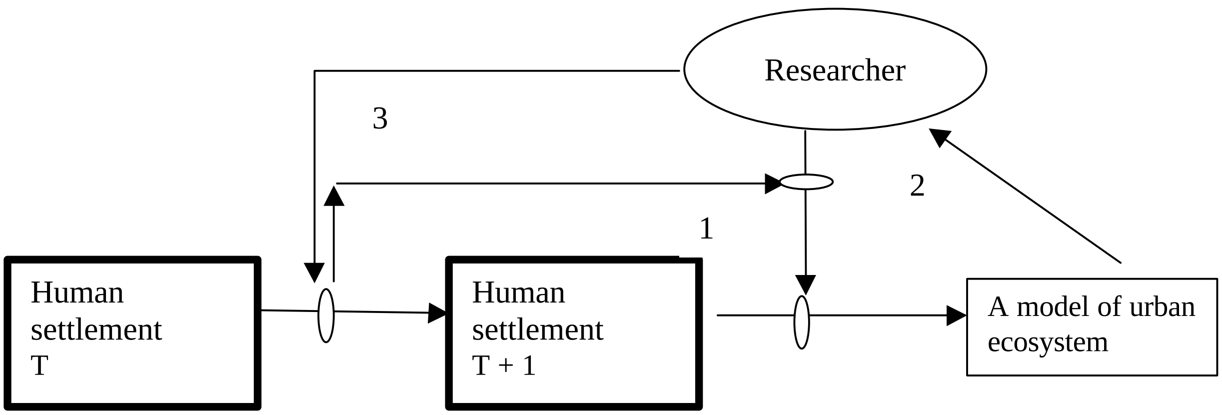

Figure 3: Second order cybernetics: man as both insider and outsider, is aware and responsible of his impact on the urban ecosystem

Feedback 1: Interaction between human settlement and the researcher's knowledge
Feedback 2: The model's impact on the researcher - to bring changes in the model
Feedback 3: Active involvement of the researcher

Approaches to urban ecosystem education in Chicago: Perspectives and processes from an environmental educator

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FOUNDATIONS

I What is the goal of urban ecosystem education?

The case studies and subsequent program design and evaluation described are built upon an internationally accepted definition of environmental education stated in the UNESCO Tbilisi Declaration[1]. It reads: *"Environmental education is a learning process that increases people's knowledge and awareness about the environment and associated challenges, develops the necessary skills and expertise to address these challenges, and fosters attitudes, motivations, and commitments to make informed decisions and take responsible action."*

II From this definition and the research work of Hungerford, Peyton, and Wilke[2] five components from this definition have been identified and deemed essential to achievement of the aforestated goal. These components articulate the ingredients and process of program design.

Awareness	Helping students acquire awareness and sensitivity to the total environment and its problems
Knowledge	Helping students acquire a basic understanding of how the environment functions
Attitude	Helping students acquire a set of values and feeling of concern for the environment, and the motivation and commitment to participate in environmental maintenance and improvement
Skill	Helping students identify the skills needed to identify, investigate and contribute to the resolution of environmental problems and issues
Participation	Helping students acquire experience in using their acquired skills in taking thoughtful, positive action toward the resolution of environmental problems and issues

III Are these goals and processes "different" for an urban audience?

Guidelines for Urban Environmental Education[3] states that *"quality urban environmental education is rooted in what experience and research indicate are the best practices of environmental education."* In urban settings, these agreed-upon goals and processes are integrated with special considerations and emphases, rooted in the community, drawing on the capacity and needs of the people as its driving force.

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[1] UNESCO. 1978 Final Report, Intergovernmental Conference on Environmental Education. Organized by UNESCO in cooperation with UNEP. Tbilisi, USSR. 14-26 October, 1977. UNESCO ED/MD/49.
[2] Hungerford, Harold R., R. Peyton and Richard J. Wilke. 1980. Goals for Curriculum Development in Environmental Education. Journal of Environmental Education 2 (3): 42-47.
[3] Fialkowski, Carol and Emilio Williams. 1996. Guidelines for Urban Environmental Education. Environmental Education in the United States—Past, Present, and Future, Collected Papers of the 1996 National Environmental Education Summit.

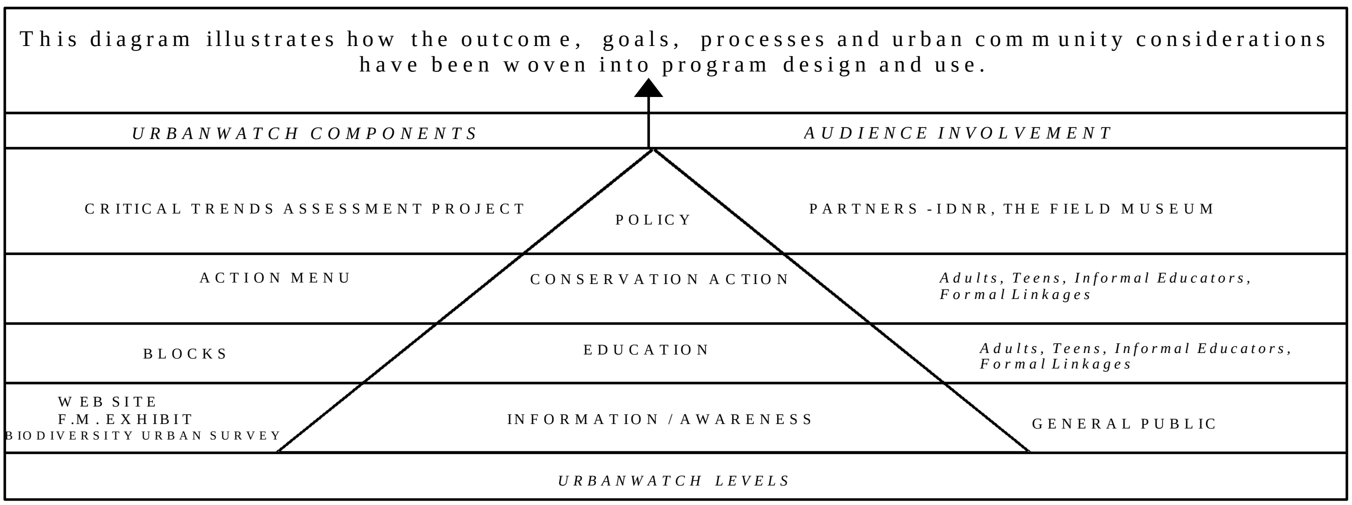
IMPLEMENTATION

The following case studies describe programs that have been built upon these goals and processes, integrated the components in program design and evaluated "success" in relation to a continuum or pyramid.

I UrbanWatch

UrbanWatch is a "citizen-scientist" program that engages adults, teens and educators in monitoring the quality of urban green space. The goal of UrbanWatch is twofold: (1) to engage urban communities in ownership of, and empowerment about, decisions relating to their local environment while (2) collecting essential scientific data on the condition of urban green space. UrbanWatch consists of three components:

1. Monitoring Protocols. Organism-specific monitoring protocols define the data to be collected and organisms to be observed.
2. Web Site. A prototype Web site is now on-line at http://cube.it.nwu.edu/urbanwatch and will become a major dissemination and training tool for UrbanWatch.
3. Implementation.



II Chicago Wilderness

Chicago Wilderness is an unprecedented coalition of 76 agencies, institutions and research organizations that have joined forces to preserve, protect, restore and manage over 200,000 acres of Chicago's "wilderness." Adopting the Tbilisi definition of environmental education and the processes identified and discussed in part II, these Chicago Wilderness institutions are linking/webbing resources to educate about local systems. Using an ecosystem organizational model, each institution has a niche and contribution in educating 8 million plus residents about Chicago's urban ecosystem.

A matrix is used to identify existing assets and reveal gaps against the goals for achievement of this integrated effort. Taken from a larger document, the sample diagram below illustrates how the processes are driving and measuring progress design and integrating partner work.

Audiences	Existing Resources	*Essential Components*				
		Awareness	Knowledge	Attitude	Skill	Participation
Teachers & School Administrators	Windows on the Wild Training ’96 & ‘97	X	X			
	Research and Report “Roadblocks to Understanding Biodiversity”	X	X			
	Communication Tools	X	X			
	An Atlas of Biodiversity	X	X			
	C W Magazine	X	X			
Pre-School – 8th Grade	Beta Project	X	X	X	X	X
	IDNR Biodiversity Kit	X	X	X	X	
	Education’s Guide to CW	X	X	X	X	X
	Mighty Acorns Expansion Project	X	X	X	X	X
	Chicago Tribune Biodiversity Supplement	X	X	X	X	

Development of environmental management systems as a tool for promoting a holistic understanding of urban ecosystems amongst local decision makers and stake holders in Durban, South Africa

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<u>Introduction</u>:
Africa is no stranger to the global rural-urban transition that will result in *Homo sapiens* entering the 21st century as a predominantly urban species. In Africa, the engines of this metamorphosis - African cities - reflect the stark reality of a continent challenged by widespread poverty, civil upheaval and environmental degradation. It is against this backdrop of human need and limited resources that the concept of urban ecosystems must be understood and developed in Africa.

The conceptualisation of urban ecosystems as a product of (often competing) social, economic and ecological forces is critical to the development of meaningful methods and approaches for advancing a more holistic understanding (i.e. broader than a "green issues" analysis) of urban ecosystems amongst all stakeholders in Africa's cities. It is within this context that Durban's Local Agenda 21 programme is reviewed. The aim is to determine the extent to which the involvement of stakeholders in the development of an environmental management system for the city (i.e. the Local Agenda 21 programme) has facilitated the development of a more holistic and widespread understanding of the urban ecosystem concept, and to examine how the social, political and economic environments have facilitated or hindered this process.

<u>Durban's Local Agenda 21 Programme</u>:
Durban's Local Agenda 21 programme is just entering its third phase. Lessons learned during Phases 1 and 2 that are pertinent to an analysis examining the manner in which different people learn concepts and skills and build them into a comprehensive understanding of urban ecosystems, include the following:

- Sectoral bias amongst so-called 'experts' involved in the development of environmental management systems at the local level often limits the development of a broader more integrated understanding of urban ecosystems. This highlights the need to build capacity amongst sectors and line-functions.
- There is a need to build an understanding of urban ecosystems that employs sustainable development principles and highlights the complex interaction between social, economic and ecological forces in the urban environment. This may require the use of diverse tools and methods for different stakeholder groups (e.g. street theatre, training opportunities, production of paper and electronic media products) to ensure that the learning process is relevant and accessible to all stakeholders.
- There is a need for all stakeholders to have a clear understanding of their role in the planning and management of the urban ecosystem. Without responsibilities being clearly defined, 'turf battles' hinder progress towards a more holistic understanding of the urban ecosystem.
- Accurate, up-to-date data are required on all aspects of the urban ecosystem.
- Social context and day-to-day needs impact significantly on the way the concept of the urban ecosystem is understood. Approaches to developing a broader understanding of the term

must therefore be relevant and sympathetic to need and social circumstances. The ‘what’s in it for me’ concept.

- Social and political tensions and / or distrust can be significant limiting factors in working towards a broader understanding of urban ecosystems (regardless of the effectiveness of the instruction / engagement methods employed).
- Tools such as resource economics are useful in underlining the importance of the ecological factors within the urban environment relative to the needs and pressures within the social and economic sectors.
- The ‘green-brown’ dichotomy in peoples’ understanding of the urban ecosystem remains a significant hurdle in developing a broader understanding of the concept.