

Environmental Education at the Science Museum

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The Science Museum at the National Autonomous University of México has recently opened a Biodiversity Hall. One of the aims of this hall is to encourage visitors to value national biodiversity and to eventually take concrete steps to protect it. It was intended that the Biodiversity Hall would transmit several concrete messages, including:

1. Biodiversity is the result of the process of evolution.
2. Biodiversity is closely related to the environment in which it develops.
3. Biodiversity is especially broad in México, due to the country's geographic setting and geologic history.
4. Biodiversity is a form of wealth for a nation, and therefore we must care for it and be proud of it.
5. Many scientists are needed in order to identify and classify our biodiversity.
6. Biodiversity includes diversity of human cultures, and México has great cultural diversity, too.
7. The development of a culture is tightly bound to the biodiversity that surrounds it.
8. Our culture is responsible for deterioration of the environment, and therefore, for endangering biodiversity.

In planning this exhibit, the informal education department of the Museum conducted a front-end evaluation through open-ended questionnaires and filmed interviews of junior high school students and teachers. Our purpose in doing so was not only to analyze concepts such as evolution, taxonomy, biodiversity, etc., but also to study attitudes. It was thought

that information about attitudes could be useful not only for the design of the hall, but for environmental education—the main goal of the exhibit.

Methods

Given the broad range of information we wanted to gather, we decided to divide our work into three parts. The first part was concerned with the breadth of biodiversity that students could visualize, the origin of that diversity, and the way students analyze and classify it. This information was gathered with the use of a questionnaire given to 50 junior high school students. Included in the questionnaire were the questions:

- How many different kinds of plants and animals exist today?
- What would you do if you found an animal that you had never seen before?
- Are plants and animals related to their environment?
- What plants and animals, or products of plants and animals, do you use at home?

The second part of the project dealt with cultural diversity and its relationship to biodiversity and the environment. It was carried out by asking another 50 high school students to write a letter describing their country. They were asked to write to an imaginary friend who did not know México, describing its different cultures and the way they relate to the environment.

The third phase, concerned with environmental deterioration and the loss of biodiversity, consisted of filmed interviews of the same students who had written the letter. This would allow members of the research team to analyze attitudes by observing the film several times and to transmit the emotional message to the rest of the staff at the Museum. For the third part of the project, six biology teachers were interviewed regarding their expectations of a Biodiversity Hall and the message concerning “biodiversity as a wealth” that they would expect to find.

Since all the questions we asked were open-ended, some of the answers overlapped other answers from different questions. For that reason, we decided to group our analysis according to specific themes in order to present a general picture of knowledge and attitude. No attempt was made to quantify responses, since we were interested in qualitative information, and because we were concerned that we would misinterpret some information by attempting to categorize and reduce the answers.

Results and Discussion

The Meaning of Biodiversity

During this study, the word *biodiversity* was never present in any questionnaire. It is a new word for most people, yet we believed the concept

could be explored by asking participants about different plants and animals that have something to do with their everyday life. In responses to our surveys, we found a wide variety of ideas regarding the number of plants and animals that exist today, from, "very few, because we are killing all of them," to, "countless." It is notable that some students can see differences between individual plants of the same species, while others answer, "all plants are the same."

Responses that revealed a wider knowledge of biodiversity, such as of birds or fruits that only grow in the southeast jungle of México, came from people who had lived for a while in this jungle. This shows that knowledge of biodiversity comes from self-experience and not from school training. The students who answered in this way were always concerned with the rapid loss of biodiversity.

The Relationship Between the Environment and Biodiversity

This is perhaps the most clear relationship that can be observed throughout the entire investigation. With very few exceptions, students believe that biodiversity is generated by the diversity of environments, and that living beings have an influence upon the environment. In fact, they consider "nature" as a unity, which is perfect for the introduction of the concept of ecosystem.

They continually express the Lamarckist idea of animals and plants "needing" to adapt themselves to environmental changes. This result agrees with the findings of Jimenez and Fernandez (1987), and Bishop and Anderson (1990).

Criteria for the Classification of Animals

Even though the conception of the magnitude of biodiversity is not very broad in the high school students who were interviewed, the question, "What would you do if you found an animal that you had never seen before?" seemed to move their imagination. (We did not ask about plants, because the classification parameters would be very different, and the scientist who was designing the hall had in mind a game for the classification of animals).

For the purpose of clarity, we have divided the criteria by which animals can be categorized into two groups: form and behavior. In the category of form, the order of importance of criteria are shape, color, number of legs, and texture of skin (hair, feathers or scales)—that is, the shape of particular characteristics like nose, mouth, ears, legs, eyes, and tail. Some of the students said that they would look for special characteristics that distinguish particular kinds of animals, and compare the animal with pictures in books.

In the category of behavior, animals could be categorized by asking questions such as, "Does it live on land or on water?," "Does it feed on milk from its mother?," "Is it born alive or from an egg?," "What does the

animal eat?," "How does it walk?" It seems specially important to know if the animal is dangerous, and how it reacts to whatever the student does to it.

These last two criteria imply a relationship between the observer and the animal observed, and focus attention on a very important attitude. Curiosity with fear could lead to behavior which is destructive towards biodiversity. Yet curiosity by itself is the ideal motivation for learning. It is important to take this into consideration when developing a program for environmental education.

The Origin of Biodiversity

In no case did we find an explicit reference to evolution as a process of diversification. We found instead many explanations on how everything changes as time goes by. The causes to which this change is attributed ranged from time itself, to "necessity," to manmade changes, or, very frequently, to breeding between members of different species.

Evolution is related to progress: animals and plants progress in much the same way as humans do. However, for many of those who were surveyed, evolution is a theory related only to monkeys and men.

Evolution was also often confused with development—changes in a body over the course of a life. When students refer to evolution, they treat it as a theory, not as a process. In few cases do they suggest that plants and animals evolve because humans evolve.

A few students made direct reference to creationism or to religious ideas. This is probably due to the school environment in which they were questioned—a public school where religious ideas are consciously avoided (see Note 1). We have found in other investigations that the conflict between creationism and evolutionary thought is mainly social (Guerra & Zamora, 1993). This could explain the difference between our results and those of Raymond & Dunn (1990) with science teachers from the United States (see Note 2).

Biodiversity and Everyday Life

Another important fact that environmental education must take into account is that students can only see a very weak relationship between biodiversity and everyday life. An extreme case is one student who stated that he never used any plant or animal at home. The majority could see the relationship between biodiversity and food, yet some of the students only considered biodiversity as ornamental. No allusion was ever made to other uses of biodiversity for textiles, medicine, building, or anything else.

The species that students considered useful for their everyday lives are related to the social and cultural environment in which they live. Roses, for example, appeared in every questionnaire because most of these students' families grow roses for sale.

The descriptions from the surveys revealed that students are conscious of the cultural diversity of México and that they value this environment-

culture relationship, especially between isolated primitive cultures and their natural environment—"they are all part of nature." This consciousness is a great basis for environmental education.

The Image of Our Country in Relation to Biodiversity

This part of the investigation was mainly based on the letters which students were asked students to write, as well as on the filmed interviews. As we expected, the image of each individual's own country had a highly emotional content involving feelings of love, pride, care, admiration, etc. These are again important aspects to consider when planning environmental education, since the development of a social conscience is necessary in order to take joint measures toward the environment (Bybee, 1991). We noticed, however, a very important confusion between prehispanic cultures that existed thousands of years ago and the many cultures that coexist today in our territory.

Attitudes Towards the Threat of Extinction on Biodiversity

None of the students missed the fact that biodiversity is being threatened. In fact, a sense of loss and dismay was noted in the answers of many of them. Such disappointment is revealed by comments such as, "México has everything to be outstanding, but there are people that don't care," and, "We don't know what we have, nor do we appreciate it."

The filmed interviews show that the problem seems too big to be solved. Respondents indicated that it was overwhelming because of the attitudes of some people who, to their eyes, could do something about it: "Powerful industrials care more about their money than about life on the planet." "Governments care more about power, than about environmental destruction." In addition to their concern with these two groups of powerful people, students also stated, "We are all careless about the way we are contaminating." "We are already too many people living on the planet."

General Discussion

The main goal of environmental education, and maybe the root of our present failure (Gomez Granell & Cervera, 1989), is change of attitude—from seeing the environment as a place to exploit and to get rid of unwanted things, to seeing it as our common home. In the effort to bring such a change of attitude, the idea that only the rich and powerful can do something is an obstacle.

The first attitude has been maintained by our culture for a very long time—it is part of our everyday life. But not all cultures have the same attitude. Native American cultures, from Alaska to the Land of Fire in Argentina, have a much more respectful attitude toward the environment. A religious feeling is involved in most of these cases, affecting people's emotional response to the problem with respect, love, and care.

In order to achieve a change of attitude, it is necessary to address not only reason, but emotions—the most powerful component of attitude. Up to now, most of our educational efforts have been directed at reason. This could explain part of our failure in environmental education (Gigliotti, 1991; Gomez Granell & Cervera, 1989; Vidart, 1978). Even though we have known since Piaget that there is no such thing as a completely rational thought, we still use this approach to education. Even though we know that using only memory is rote learning (Novak, 1993), we still keep feeding students with only cold facts. Environmental education has come to the point where it does not represent whether we pass or fail an exam, but whether we achieve a better environment or keep deteriorating it. Maybe it is time we start using all our knowledge to try to reach our goal.

During the past few years, three important branches of knowledge concerning education have been converging: neurophysiology, cognitive psychology, and artificial intelligence. There is agreement among all of these fields that learning is a process of integration—that is, our brain integrates information all the time. Past information is integrated with new information, visual information relating form, color, and motion is integrated, and language is the product of the integration of signs, sounds, and speech (Fischbach, 1992). Why then should we keep teaching isolated ideas?

Ideas should be presented to students using visual information, sounds, hands-on activities and so on, in such a way that all of these together generate a special environment. The ideal place to create a holistic learning environment is a museum that uses movies, theater, walk-in exhibits, touch devices, games, etc., and designs its exhibits using front-end evaluation—so that the prior knowledge of visitors is taken into consideration.

The information presented this way should have a consistent message; they should show various aspects of the same idea, and say the same thing in different ways. Then newly formed neuronal connections in the working memory will be reinforced until the information is filed into permanent memory.

In the case of environmental education this is quite easy. The central message is, "The environment is not a place to exploit or to dispose of garbage. It is your home, and you are destroying it." One way to project this same message in a different way is to show different forms of life and how they not only feed out of the environment and dispose of their debris in it, but how they play a part in the environment, including what they feed and what they discard. All of these would transmit the message, yet we found that this message is already in the conscious memory of most of the students we questioned.

There is a second message that this investigation has made clear for us, dealing with the social dimension of environmental education. This message is, "To save your home, your personal effort is necessary. It is the sum of personal efforts that makes possible the big change we are so

urgently needing." This second part of the message is difficult to transmit, because students, and maybe a large part of society, do not believe it. The very complex pattern of economic interests which are responsible for environmental deterioration makes it look like a formidable task. Yet, here we can learn from the experience of environmentalists all over the world who are fighting to save biodiversity by applying social pressure.

People who are momentarily moved by the exhibit toward a change of attitude need a social reinforcement in order to change their everyday life. This reinforcement could be fostered, if some kind of society, community, or informal group of friends is housed by the Museum. The community promoted by the Museum should be oriented toward taking concrete measures in favor of its particular environment. This should be done in such a way that people can really experiment in their everyday life and discover that the effort of recycling, preserving, saving water, saving energy, etc. has definite and immediate benefit for them as individuals, for their families, and for the community as a whole. Periodic meetings can favor a continuous increase in information about forms of social development that are less harmful to the environment. Meetings can develop a certain cohesion within the group, and eventually the community can grow and find solutions for larger problems.

For all of these positive outcomes to be possible, the design of the exhibit must take into consideration the environmental problems of each community and address them directly. The problems of a city are very different from the problems of a specific rural community, precisely for the same reasons that biodiversity exists: they are part of the environment, and they respond to environmental characteristics. The consciousness of being part of the environment comes from the knowledge of other parts of the same environment and of the ways in which we depend upon each other. Individual consciousness must grow into social consciousness, and then into ecological consciousness, step by step.

Conclusion

The Science Museum has the possibility of becoming a holistic learning environment which is very useful for environmental education, because of its particular suitability for the task. Exhibits for this purpose should be designed for specific communities and in relation to specific problems that can be attacked by the action of small groups of people fostered by the Museum.

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Notes

1. In México, public schools were separated from the Catholic church through a severe social conflict—almost a civil war. For this reason, religious themes are avoided.
2. We suggest that the conflict between creationism and evolution is mainly social because our interviews showed that students did not have intellectual problems deciding whether God created life, or life began as a result of chemical evolution—they considered both as possibilities. Their real problem was the social reaction to their comments, due to the cultural context described above.

Our results differed from those of Raymond and Dunn (1990), in that their results showed that 20% of the teachers believed that the Bible is a trustworthy reference on the age of the earth and the origin of life. Our results suggest that the percentage of students who believe in creationism varies according to the social environment in which the individuals are questioned. The results of these two studies are not directly comparable, however, because one refers to teachers, the other to students. One was done through a questionnaire, while the other was done through a collective interview. Yet, based on the work of Raymond and Dunn (1990), we expected a definite percentage of creationists. Instead, we found many students doubting, and considering both points of view.