Chapter 13: Naive Notions and Science Learning

Minda Borun
The Franklin Institute Science Museum

Introduction

The Franklin Institute Science Museum is engaged in an eighteen-month study to discover visitors' misconceptions about gravity and air pressure and to develop exhibits which help people restructure these concepts and achieve an understanding of the scientific explanation. The project is intended to establish a new model for the design of effective science museum exhibits.

The first phase of the project involved video-taping interviews with museum visitors in four age categories from 9 years through adult, in order to identify their misconceptions about gravity and air pressure. Phase two will entail the development and revision of prototype exhibits which deal with key aspects of these misconceptions to encourage visitors to confront the limitations of their explanations and to understand the way scientists explain these phenomena.

Background

Recent research by science educators and educational psychologists on what are variously termed "misconceptions", "preconceptions", "naive notions" and "alternative schema" demands a revolution in our approach to science teaching in the classroom and in the science museum (Carey, 1986; Champagne & Klopfer,1983; Hawkins, Apelman, Colton, & Flexer, 1982; Helm & Novak, 1983; Nussbaum & Novick, 1981; Resnick & Gelman, 1984). We are not dealing with a "clean slate" onto which educators may indelibly inscribe their explanations. People interpret what they see and experience in terms of their own notions. In informal encounters with phenomena, they arrive at a number of partially correct explanations.

In order to enhance the educational value of hands-on science exhibits, we must first discern widespread naive conceptions and then address them in exhibits. Only then can science museums hope to establish a common meeting ground with their visitors and accomplish the necessary restructuring that results in enduring cognitive gains.

While there has been considerable research done on misconceptions in science learning (e.g., Clement, 1982; McClosky, 1982; McDermott, 1984; Nussbaum, 1979; Pines & Novak, 1985), most of these studies have looked at children in classrooms. However, it seems clear that misconceptions frequently persist in adults. In the absence of experiences which cause them to see the flaws in these early explanations, people get stuck. The science museum attracts visitors of all ages, affording an opportunity to study misconceptions across a broad age range. Thus, it is an excellent laboratory for the study of misconceptions.

Objectives

The objectives of the current project are:

- To discover widespread misconceptions about gravity and air pressure.
- To develop exhibits which rectify these misconceptions.
- To show that front-end analysis of visitors' misconceptions allows us to significantly increase the effectiveness of exhibits.

Results

At this point the results are more qualitative than quantitative. Preliminary interviews with a random sample of visitors to the gravity cone exhibit in the Franklin Institute Museum indicate that approximately one third of these visitors (regardless of age) believe that gravity is in some way connected to air pressure. Quotes from the visitors will give the reader an idea of some of these naive notions about gravity.

- "It's all around."
- "It's equal everywhere."
- "It makes things stay put, not float."
- "It's in the air."
- "It comes from the solar system and planets."
- "Gravity is the layer of air mass... 14.3 pounds of air per square inch."
- "If a ball is 4 square inches, you have 56 pounds of pressure on the ball, so it falls."
- "If an object is a mile high, the air is a lot thinner, so there's less pressure."
- "As you get farther down towards the earth, it would pick up speed because you have a lot more pressure behind it."

- "There is no gravity on the moon."
- "Air pressure, which causes gravity, holds the planets in orbit and makes the tides."
- "Without air pressure things would not fall."

Since people often confuse gravity and air pressure, an exhibit on gravity should address this misconception in an explicit manner.

Significance

Attendance at science museums has risen dramatically in the past decade. Science museums have the potential to offer rich, meaningful educational experiences to the general public. But, this potential is only partially realized. Too often exhibits fail to connect with the visitor. Language is too technical, concepts are presented at too high a level, and fundamental misconceptions are ignored.

Museums must give visitors a more important role in the design of exhibits. This can be accomplished through the process of formative evaluation of exhibit prototypes, incorporating feedback from visitors into the design process.

The implications of research on misconceptions complicates the task of teaching science. New teaching techniques are needed to restructure misconceptions. This is more difficult than simple didactic presentations. But, consider the potential rewards. People may come to truly understand science concepts instead of merely being able to recite a string of memorized words. They may be able to explain phenomena in the world around them instead of being confused and mystified. They may be able to make intelligent judgements on issues of science policy, because they know what is really involved. Surely, these outcomes are worth the effort.

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