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Public Understanding of Science vs. Public Understanding of Research

Hyman Field, Senior Advisor for Public Understanding of Research, National Science Foundation

Patricia Powell, AAAS/NSF Fellow

The current world research agenda is comprehensive. The results of many studies and experiments in which scientists are currently engaged will undoubtedly have profound impacts on the lives of citizens in developed and developing nations. Yet few people even know what research is being conducted, much less understand why it is being done and what the potential implications may be. This is a critical shortcoming of our public information system. Given the frenetic pace of science research in multi-disciplinary fields, it is increasingly vital that the public be made aware of new findings in a coherent manner. The field of informal, public education is uniquely poised to reach the public at all levels, so that those who need the information most, i.e. those who make or will make decisions for themselves and their families, have access to accurate, up-to-date, unbiased and substantive information.

Traditionally, the field of informal education has focused on informing the public about basic science – here defined as helping laypersons understand that which is already known, improving their understanding of the process by which science is conducted, and engaging them in science activities. This has been the primary focus of the Informal Science Education (ISE) program at the National Science Foundation (NSF). Beginning with a funding base of $4 million in 1984 that has grown to $56 million in 2001, the ISE Program has supported media-based projects, exhibits in museums and science centers, and science activities conducted through youth- and community-based groups. The goals of the projects funded have focused largely on conveying **basic science** rather than on examining **contemporary research**. When research is included in these projects it primarily consists of the results of studies that have been completed, conclusions drawn, and for which the implications for science and society are clear. Rarely do such projects describe **on-going research**.

The scope of current research is immense. It is delving into exciting, unexplored territory and the pace with which research is progressing can be mind boggling. The need is great, therefore, for the public to understand what research is being conducted; to consider what

the social, ethical, and policy implications of new findings may be; and to recognize the importance of continued support for both basic and applied research. Moreover according to the "Communicating Science" section of the Ehlers report to the House Committee on Science which recommended congressional actions regarding research and science: "Research sponsored by the Federal government should be more readily available to the general public, both to inform them and to demonstrate that they are getting value for the money the government spends on research. Agencies that support scientific research have an obligation to explain that research to the public in a clear and concise way."[1]

Many people already express an interest in research and realize the importance of being knowledgeable about cutting edge research, especially in areas such as global climate change and genome research that may have direct relevance to their lives. In a national survey conducted for *Science and Engineering Indicators 2000,* between 67% to 70% of Americans expressed an interest in new scientific discoveries.[2] On the other hand, the public's knowledge and comfort level regarding current research is quite low. Of those who indicated that they are very interested in science and technology, only 17% described themselves as well informed and 30% thought they were poorly informed.[3] In a 1999 survey, only 21% of Americans met a standard for minimal understanding of the nature of scientific inquiry[4]. Moreover, even given the relatively high interest level in new scientific discoveries and technology, only 10% of the public can be regarded as attentive to information in these areas[5]. It also is disturbing to note the attitudes that much of the public holds about science and technology. In 1997, for instance, 63% of the public thought that the same scientific evidence can be interpreted to fit opposing views, 72% thought that scientific research is almost always affected by the values held by the researcher, and 40% thought that technology has become dangerous and unmanageable[6].

By its nature, current research is difficult to present in public venues. It is continually being modified according to the latest findings. Rather than presenting an established set of facts, educators must track a moving target and try to predict its trajectory. The on-going nature of research does not lend itself to the means we traditionally use to inform the public. According to the *Science and Engineering Indicators 2000*, for instance, 52% of journalists polled agreed with the statement that "the news media do not cover science because they are interested in instant answers and short-term results."[7] As difficult a task as it is to present state-of-the-art research, it is increasingly important that the public understand current developments in research as these developments have the potential to

[1] Unlocking our Future: Toward a New National Science Policy, A Report to Congress by the House Committee on Science, September 24, 1998
[2] National Science Board, *Science & Engineering Indicators 2000*. Arlington, VA: National Science Foundation, 2000 (NSB-00-1), pg. 8-5.
[3] Ibid. pg. 8-7.
[4] Ibid. pg. 8-12.
[5] Ibid. pg. 8-9.
[6] K.G. Hebron and H.C. Jenkins-Smith, Public Perspectives on Nuclear Security (Albuquerque, New Mexico: The University of New Mexico Institute for Public Policy, 1998), pp. 210-11, 213.
[7] National Science Board, *Science & Engineering Indicators 2000*. Arlington, VA: National Science Foundation, 2000 (NSB-00-1), pg. 8-29.

profoundly impact both personal decisions and larger policy issues. Topics such as global climate change, genetically modified organisms, information technology and research into learning are not only of interest to the researcher but affect everything from commonplace decisions such as whether or not to purchase genetically modified foods to policy debates on global warming to how we teach our children. The more emotionally charged an issue becomes, the greater the need for an unbiased source of substantive information. The field of informal, public education is uniquely positioned to provide an orderly dissemination of the nature and scope of on-going and emerging research to the general public, but it will require altering the way the field goes about conducting its business.

The challenge to those charged with public science education is to design and implement effective methods of explaining on-going research to the layperson that will attract and hold their attention and to find channels of communication that are readily accessible to the lay public. Because of the differences in nature between **established science** and **current research**, they require different modes of presentation. By focusing on **established science**, for which the results are demonstrable and the implications for the average citizen clear, a single, inclusive exhibit, film or other presentation is generally sufficient to convey the information and show applications of the discoveries. It is possible to reconstruct the steps that led to a significant discovery thereby giving a sense of the process of discovery and underscoring the significance of basic research which often sets the stage for major breakthroughs. In addition, a presentation can be developed which remains accurate and therefore usable for a relatively long period of time.

By contrast, **on-going research** is not static and new results are constantly changing the course of an investigation. Therefore it is necessary to frequently update the information, making it impossible to provide accurate and complete information in a single presentation. Rather, a format that allows one to revisit a topic numerous times is essential. For ongoing research, coverage is likely to include unproductive as well as successful ventures, giving some insight into the process by which the research direction is altered by new data. In addition, one can only speculate on possible applications of the new technology.

Since research is an on-going process, often lacking definitive answers, it tends to generate controversy. The public needs to understand the positive role of controversy in shaping the research process rather than viewing it as an indication of poor science or befuddled scientists. Also a distinction must be made between uncertainty generated as a normal part of the research process and uncertainty as the result of a poorly designed or conducted investigation. This necessitates some public insight into the research process. Laypersons need to understand something, for instance, about what are appropriate and adequate controls and about the process of peer review.

Much of current research has raised a number of social, ethical and policy issues. Issues such as: labeling of genetically modified food, cybercrime and an individual's right to privacy, environmental legislation, and genetic testing for incurable conditions are highly controversial, therefore it is important to provide a forum for discussion of these issues in the context of what is known scientifically and what still needs to be determined.

As is often done in the more traditional presentations of science, it is essential to emphasize the contribution of basic research to the current line of investigation. Often the ramifications of basic research are not clear initially. In fact, applications may be very different from the original research. For example, the study of how an infectious bacterium of plants causes disease set the stage for the field of plant genetic engineering. Virtually all of the hot research topics today have their foundation in basic research.

The National Science Foundation is currently developing a Public Understanding of Research (PUR) effort. While many of the same organizations and individuals involved with Informal Science Education Program projects may participate in PUR, the new effort will shift the emphasis to include different content and will require innovative design and delivery strategies. Some of the distinctions between the efforts include:

INFORMAL SCIENCE EDUCATION	PUBLIC UNDERSTANDING OF RESEARCH
• Presents established science knowledge	• Examines research into the unknown
• Often a one-time learning experience	• Must be an on-going presentation that follows research as it develops
• Usually presents information via a single medium (e.g., an exhibit or a media program)	• Should be a coordinated multimedia endeavor that disseminates information about broad areas of major research via multiple channels to which the audience attends (e.g. television, internet, radio, exhibits, print)
• Examines what applications of science have been in the past	• Discusses what the applications of research may be.
• Presents the process of research but often in a simplified fashion based on hindsight. Portrays scientific investigation as a well-defined, linear process	• Presents the process of research as it is happening including the set-backs, detours, and disagreements as well as the positive aspects of new discoveries and exciting new directions for exploration
• Presents scientists who have made significant contributions	• Introduces scientists currently working on various fields of research
	• Engages the public in dialogue about the ethical, social, and policy issues related to new research.
	• It is essential to have constant feedback from the public to assure the effort is addressing public interests, questions, and concerns and to assess the effectiveness of what is being delivered.

Whereas some informal science education projects certainly have elements in common with a PUR project, certain aspects are missing. For example, the recent Nova/Frontline production on genetically modified (GM) food, *Harvest of Fear*, described current research as well as exploring the controversy surrounding this topic. An extensive website was created to complement the television production. If this program were presented as part of the PUR effort, the topic of GM food would be revisited on subsequent programs, with updates on emerging research and the ethical and policy issues associated with the topic. In addition, the coordination among media providers would be more extensive, perhaps including related science center exhibits, radio broadcasts and/or a frequently updated, interactive website.

Such an effort requires informal educators to rethink their goals and to revise their methods for designing and developing public education projects. A greater emphasis on the present and the future will require that they create much more adaptable learning conditions. Exhibits, media projects, community and youth activities will take on a new look and they must be flexible so that content can be changed as new developments occur. The methods for developing informal learning projects and materials will also have to change. No longer will informal educators have the luxury of spending a year or more in design and development of projects. Content often will be time sensitive, so learning experiences must be developed and disseminated within weeks, or even days, of when new information becomes available. The process must become much more iterative with informal educators responding to input from the research fields and from the public.

Deciding how best to reach the public also presents a challenge. The public attends to many different media for their news and information. They watch television news, listen to informational radio programming, visit museums and science centers, access the Internet, read popular magazines, and talk with friends and colleagues; they may get most of their information about a research area from one of these media or they may get bits and pieces from multiple sources. For example, a news story may generate initial interest in a topic but the viewer may then go to a website to find answers to specific questions. A Public Understanding of Research effort, therefore, is likely to have greater effectiveness if multiple channels are engaged in the dissemination of basic information about research. In addition, diverse audiences are best reached by a range of different providers. Informal educators need to explore new ways to coordinate and collaborate among themselves so that all involved are conveying information about some agreed on broad areas of research, e.g. genetic research, information technology, neuroscience and learning, nanotechnology, etc. The specific content and format will vary among collaborators but, by coordinating their efforts, the informal educators will expose the public to the research in multiple venues. This type of coordinated effort will increase the likelihood that those who only attend to a single venue will be reached. More importantly, it will provide those who attend to more than one venue a much deeper understanding of the scope and depth of the research. Moreover by reaching a greater percentage of the population during a specific time frame, the likelihood of promoting a substantive dialogue between individuals about current research, its relevance to daily life, and the salient issues associated with it is increased.

In order to engage the maximum number of people it also is incumbent on the providers to devise means of alerting the public to the availability of information in research and of attracting them to attend to the messages. Promotion that will reach the lay public where they are most likely to encounter it must be developed. Since audiences are not homogeneous, it also will be necessary to employ different approaches to engage different sectors of the population. For example, women tend to be most interested in issues that affect the health and well being of themselves and their families.[8] Therefore a presentation on nanotechnology might be more appealing to women if the possibilities for medical advances are emphasized than if the focus is on technology and its implications for the development of electronics. The target audience will also influence the type of information and the manner in which it is presented. Policy makers might be interested in the relationship between current research and today's pressing needs presented in a succinct, easily digestible (and quotable) format, whereas the attentive public might want a more comprehensive view, perhaps including a personal interest story about the investigation.

PUR at the National Science Foundation is an evolving effort. It is intended to examine the broad range of research on a national and international basis. NSF alone cannot accomplish the goal of achieving a public that is more literate about research.. Moreover, coordination among and partnerships with the research community and the full range of public educators will be vital to developing and sustaining a successful Public Understanding of Research effort. While many of the parameters as discussed above have been tentatively identified, the endeavor will grow and change based on feedback as project components are implemented and tested. NSF looks to both researchers and to the informal education field to help develop successful strategies for reaching the public with information about research and to become partners in this important undertaking.

[8] Barbara Flagg, Director Mutimedia Research, presentation at the workshop: *Enhancing the Public Understanding of Research*, Museum of Science, Boston, MA Feb 11-3, 2001.