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THE CONTRIBUTION OF FREE-CHOICE LEARNING TO PUBLIC UNDERSTANDING OF SCIENCE

John H. Falk

SUMMARY

There is no single right way to learn things, and no single place or even moment in which we learn. All learning happens continuously, from many different sources, and in many different ways. There are three main educational sectors, the formal education sector of schools and universities, the workplace, and the free-choice learning sector. Of the three, the most frequently over-looked is the free-choice learning sector. The free-choice learning sector includes museums, television, radio, the Internet, magazines, newspapers, books, parks, community organizations of all types: youth, adult, religious, environmental, health, sports and recreation. It is a vast educational infrastructure that helps to support the on-going and continuous learning of all citizens. Recent research suggests that nearly half of the public's science understanding and learning derives from the free-choice learning sector. Hence it is incumbent on science educational policy makers and practitioners to recognize the fundamental role that free-choice learning makes in public understanding of science.

RESUMEN

No hay una sola manera de aprender, ni un solo lugar o momento en los cuales aprendemos. Todo aprendizaje tiene lugar continuamente, desde muchas fuentes y de muchas maneras diferentes. Existen tres sectores educativos principales, el sector educativo formal de escuelas y universidades, el lugar de trabajo, y el sector de libre aprendizaje. De los tres, el que más frecuentemente es descuidado es el libre aprendizaje. Este último sector de aprendizaje incluye museos, televisión, radio, la Internet, revistas, periódicos, libros, parques y organizaciones comunitarias de todo tipo: juveniles, de adultos, religiosas, ambientalistas, de salud, deportes y recreación. Es una vasta infraestructura educativa que apoya el aprendizaje 'sobre la marcha' y continuo de todos los ciudadanos. Investigaciones recientes sugieren que cerca de la mitad del aprendizaje y comprensión de la ciencia por el público proviene del sector del libre aprendizaje. Por ello es necesario que quienes formulan políticas educativas y quienes las llevan a la práctica reconozcan el papel fundamental que tiene el libre aprendizaje en la comprensión pública de la ciencia.

Learning is something we do all the time, throughout our lives. Learning happens in school and at home, in classrooms, in workplaces, in museums, while watching television, while playing sports and while talking with friends (Falk, 2001). We learn both through formal instruction and on our own. Some of what we learn, we learn because we have to learn it. If we want to drive a car, we need to learn the rules of the road and pass a driving test. If we want to practice medicine, we need to learn about the human body and how it functions and pass a board-certified examination. However, most of what we learn in our lives we learn not because we have to, but because we want to, because events in our life intrinsically motivate us to find out more (McCombs and Whisler, 1989; McCombs, 1991). Under these conditions, we learn not only what we want, but also where we want, when we want, and with whom we want. This is free-choice learning – lifelong learning that is intrinsically motivated and largely under the choice and control of the learner (cf., Falk and Dierking, 2000; Falk, 2001).

Learning can, and often is, facilitated by teachers, but our teachers are not always authority figures standing at the front of a classroom. Parents are teachers, so are youth and religious leaders, and some of our best teachers are our friends (Medrich, 1991; Korpan et al., 1997). Often, our teachers are objects like books, web sites, television shows or exhibitions. What we learn from these teachers may be what they intended, but just as likely our lessons learned are different, unique to our particular needs and interests (Falk and Dierking, 1992; 2000).

There is no single right way to learn things, and no single place or even moment in which we learn. All of our learning happens continuously, from many different sources, and in many different ways (Medrich, 1991; Anderson, 1999; Bransford *et al.*, 1999). We are not born knowing what is important to learn, but as a society, as a community of learners, we must be guided to discover what is important to learn (Rogoff and Lave, 1984; Ogbu, 1995). Importantly, all learning is situated within the unique personal, sociocultural and physical context in which it occurs (Falk and Dierking, 1992; 2000). In other words, what people learn depends upon what they already know and understand, whom they are with when they learn, where they are when they learn, and importantly why they are motivated to learn in the first place. There are three main educational sectors where the public can receive this learning guidance –the formal education sector of schools and universities, the workplace, and the free-choice learning sector (Falk and Dierking, in press). Of the three, the least understood is the free-choice learning sector. The free-choice learning sector includes museums, television, radio, the Internet, magazines, newspapers, books, parks, com-

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RESUMO

Não há uma só maneira de aprender, nem um só lugar ou momento nos quais aprendemos. Toda aprendizagem tem um lugar contínuo, desde muitas fontes e de muitas maneiras diferentes. Existem três setores educativos principais, o setor educativo formal de escolas e universidades, o lugar de trabalho, e o setor de livre aprendizagem. Dos três, o que mais é descuidado é o de livre alvitro. Este último setor de aprendizagem inclui museus, televisão, rádio, a Internet, revistas, jornais, livros, parques e organizações comunitárias de todo tipo: juvenis, de adultos, religiosas, ambientalistas, de saúde, esportes e recreação. É uma vasta infra-estrutura educativa que apoia a aprendizagem 'sobre a marcha' de todos os cidadãos. Pesquisas recentes sugerem que aproximadamente a metade da aprendizagem e compreensão da ciência pelo público é oriunda do setor de livre aprendizagem. Por isso é necessário que aqueles que formulam políticas educativas e aqueles que as levam em prática reconheçam o papel fundamental que tem a livre aprendizagem na compreensão pública da ciência.

munity organizations of all types– youth, adult, religious, environmental, health, sports and recreation, and a complex interpersonal network of families, friends and acquaintances. The free-choice learning sector is a vast educational infrastructure that helps to support the on-going and continuous learning of all citizens.

All three sectors are important; all three are essential for lifelong learning. Clearly, there is a need in our lives for formal education. Formal education is the place where professionals help guide us in the development of basic through advanced skills and introduce us to new realms of knowledge. There is also a need in our lives for career-directed learning. The workplace is where we learn the skills and abilities necessary to do productive work, and in the process earn the money we need to sustain our lives. But so too, there is a need for free-choice learning. The free-choice learning sector represents a vast array of information resources which provide the opportunity to explore any of thousands of topics, whether shallowly or deeply, occasionally or frequently. The resources of the free-choice learning sector afford us opportunities to develop a better understanding of ourselves, our family, our society and our world.

All three of these educational sectors currently exist and all are large and active. However, the importance on public learning of one of these sectors, the free-choice learning sector, has been consistently under-appreciated by government and policy makers. In the U.S. for example, although the federal government supports a range of free-choice educational institutions, e.g., libraries, museums, community-based organization, national parks, public television and radio, the total of these subsidies equals about 1% of total expenditures on education (Congressional Record, 2001; Lewenstein, 2001). Modern society has developed this bad habit of equating the words learning, education and school, treating them as if they were synonyms. As has been true for hundreds of years, most people today acquire most of the knowledge, understanding and information they require for their daily lives outside of school; including their knowledge, understanding and information about science. Given the vantage point of those who work within the science community, individuals deeply invested in the formal education sector, this statement seems at best surprising, at worst disturbing, and in either case dubious. I will use the United States as a case study to make my case.

The free-choice learning sector is a vast educational infrastructure that helps to support the on-going and continuous learning of all citizens.

For nearly half a century, science education has been an educational priority in the United States. Billions of dollars have been poured into schools at every level to enhance the quantity and quality of science education. Science is a subject taught in every school system in the country, not once, but repeatedly from elementary through high school and college. However, on national tests of science knowledge, American adults fare poorly. Only those with college level courses in science do well on these tests (cf., Miller, 1987; 1998; 2001; Miller and Pifer, 1996).

Given my interest in public understanding of science, in 1997 colleagues and I launched an investigation to help determine how, when, where and why people learn science and technology (Falk *et al.*, 2001). As one part of this investigation, we conducted a random telephone survey of Los Angeles, California residents (N = 1,002) and asked them questions about their science and technology knowledge. The sample of all adults (over 18 years of age) was broadly representative of the Los Angeles community and closely mirrored U.S. Census data (U.S. Census Bureau, 1992) for age, race, ethnicity, household income, educational attainment and gender. Interviews were conducted in both English (90%) and Spanish (10%). As part of the interview, people were asked to rate their interest in science and technology on a scale from 1 to 10, 1 = very low interest and 10 = very high interest. The median response was 7.0 (mode = 10, S.D. = 2.6); nearly half indicated a scale score of 8 or higher. Consistently high interest in science and technology was expressed, regardless of age, race, ethnicity, income, education or gender. Similarly, on a five-point scale, people were asked to rate their knowledge of science and technology. Respondents overwhelmingly rated their knowledge of science and technology to be average, or slightly higher than average. Thus, most respondents in this survey self-reported having a very high interest in science and technology and possessing a knowledge level about science and technology equivalent to or slightly higher than the average. Obviously, the public's self-perception of their science knowledge was somewhat inflated. More importantly, though, the results suggest a discrepancy with the previously cited research on public understanding of science. How can we square the public's perception that their knowledge of science is average or better, and by inference adequate or better, with the expert's opinion that the public's knowledge of science is poor? One explanation is that the public appreciates that "average knowledge" is actually "poor knowledge," hence the two data sets are compatible. Alternatively, the public's and expert's concepts of science "knowledge" are incongruent; the public's and expert's judgements are based on differing criteria of what represents "adequate and appropriate knowledge." We hypoth-

esized that the latter explanation was more likely true.

Our suspicion was that the discrepancy had to do with the nature of the questions asked in these national "science literacy" investigations. The questions asked on these tests were typically school-like multiple-choice and short-answer questions; many drawn straight from school textbooks. They were representative of the kinds of questions asked in a survey course of science. Included were questions such as how does a laser work or "define the term *radiation.*" We questioned whether knowledge of these topics, though perhaps interesting and potentially useful, were actually indicative of the public's real science knowledge. We hypothesized that the public was far more likely to have situation-specific knowledge of science; a deeper understanding of a few selected areas rather than generalized knowledge of the entire domain of science as is typically presented in school. Although these science literacy studies were interesting, they were prone to providing circular conclusions –those doing well on a school-like assessment of science were most likely to be those who had completed the most school courses in science. Unfortunately, individuals who learned science in other contexts and/or for different reasons were less likely to do well on these tests. Therefore, the tests did not provide valid evidence of who was or was not scientifically knowledgeable.

Given the importance of science and technology in modern life, we believe that every citizen, at least in America, actually does know quite a bit about science, but it is not a broad, generalized "textbook" type of knowledge. Instead, the public's knowledge of science is likely to vary widely, be very topic-specific, and very practical. Depending upon need and interest, one person is likely to know a lot about biology and another about health; few outside of the science community are likely to know a lot about all areas of science.

TABLE I
RANKING OF SOURCES RELIED UPON "SOME OR A LOT" OR "NOT AT ALL" FOR LEARNING ABOUT SCIENCE AND TECHNOLOGY (n = 1007)

Relied Upon "Some or A Lot"			Relied Upon "Not At All"	
Rank Order	*%*	*Category/ Source*	*%*	*Category/ Source*
1st	76%	Books, magazines, not for school	37%	Radio, audiotapes
2nd	74%	Life experiences	23%	On the job
	74%	TV, cable		
3rd	68%	School, courses	18%	Family/ friends
4th	65%	Museums, zoos	15%	School, courses
5th	57%	On the job	13%	Museums, zoos
6th	55%	Family/ friends	10%	TV, cable
7th	31%	Radio, audiotapes	8%	Books, magazines, not for school
8th			8%	Life experiences

Parenthetically, the same would be true for any domain of knowledge –non-lawyers would know little about the law, non-farmers would know little about current agricultural practices, non-artists would know little about contemporary art, and non-bankers would know little about the money supply; all arguably important aspects of life in our modern world.

To test this hypothesis we conducted a second round of interviews (N=877), where we asked each person to describe some area of science and/or technology in which they felt they knew more than the average person (Falk and Coulson, 2000). We also asked people to tell us why they had acquired their knowledge in this area of science and/or technology and from what source they acquired it. First of all, virtually everyone we talked to felt that there was at least one area of science and/or technology that they had some reasonable knowledge of, a knowledge that exceeded the norm. The areas described ranged from astronomy to zoology. Some people described very specific areas of scientific or technological knowledge such as the workings of the internal combustion engine or the physiological basis of depression; others gave more general categories of knowledge such as health or the environment. Although we did not systematically "test" people's knowledge to determine the degree to which their self-report was reliable, we did attempt to superficially validate people's claims of knowledge by asking them to give us some examples of their understanding. With only a few exceptions, respondent's self-reported knowledge was credible.

When queried as to why they came to be knowledgeable in this area of science or technology, most people claimed that the motivation behind their knowledge was simply interest and curiosity, though occasionally the motivation was a personal crisis such as an ill relative. For example, one individual described their long-standing interest in insects and described himself as "an avid butterfly collector." Another individual gave the example of a sister diagnosed with leukemia prompting considerable research on her part about the disease. A third individual stated they had always been interested in medicine and pursued that interest into a job as a laboratory technician. Professional and work-related reasons, such as the latter example, were relatively common. However, not a single individual in our sample suggested that their motivation for science learning was passing a test or succeeding in school. Across the board, people stated that at some point in their life, something about the science or technology topic they claimed a special knowledge of had piqued their curiosity. And it was this curiosity for the subject that had primarily prompted them to continue pursuing ever, greater knowledge and understanding of the subject, regardless of what source(s) they used to acquire their knowledge.

Although the public's sources for acquiring knowledge of science and technology were many, they could be easily sorted into deriving from one of the three broad educational sectors –school, work or free-choice. Roughly a third of the people surveyed claimed to have primarily learned their favored science and/or technology topic in school. Just under a quarter of respondents said they acquired their knowledge on the job or as part of their work. The largest number of people, nearly half of all those surveyed, claimed to have learned their science and/or technology during their leisure time, through some kind of free-choice learning experience. People described learning science by using the Internet, reading magazines and books, going to museums, zoos and aquariums, and participating in special-interest clubs and groups. Although school was an important source of scientific learning, it was not the primary source for most people.

These findings were consistent with the data we had collected in the first set of inter-

views. In that first study respondents were probed about how they generally stayed informed about science and technology. People were provided with a list of possible sources (generated from an earlier qualitative pilot study), and asked "Which of the following sources have you relied upon when you learned about science and/or technology?" Individuals were also asked to independently indicate "Which of the following sources did you never rely upon when you learned about science and/or technology?" The results (Table I) showed that the general public relies upon multiple sources of information for their science and technology knowledge, in particular free-choice learning resources such as books, television, life experiences and museums.

Data collected by the U.S. National Science Board corroborates the widespread utilization of free-choice learning sources for acquiring science information year (National Science Board, 1998). The NSB study found that 50% of American adults read a daily newspaper including articles on science, 15% read one or more science magazines each month, and a majority of Americans watched one or more science television shows each month. Approximately two-thirds of adults visited a science or natural history museum at least once a year and a third of Americans reported that they had purchased one or more science books during the preceding year. More narrowly focused studies have come to similar conclusions (e.g., Korpan, *et al.*, 1997; Anderson, 1999).

Collectively, these studies document the important role non-school sources play in sustaining lifelong learning in general and science learning in particular. The data would suggest that even though science is taught in school, science is not exclusively nor even primarily learned in school. This statement is not intended as a condemnation of school-based learning, but rather to emphasize the fundamental role played by free-choice learning. Each of the three educational sectors significantly contribute to public science learning. However, because of the highly situation-specific nature of science learning, the free-choice sector currently affords more people, more educational opportunities, more of the time. At least this appears to be the case in the United States.

In conclusion, there is strong evidence that a significant percentage of all lifelong science learning occurs within the free-choice sector. As the nascent Information Age expands and replaces the Industrial Age, and educational tools like the Internet mature, the importance of free-choice science learning should only increase. Hence it is incumbent on science educational policy makers and practitioners to fully recognize the essential role that free-choice learning plays in public understanding of science. Currently the contributions of the free-choice learning sector are typically ignored or relegated to second-class status during funding and policy deliberations. The realities of public science learning would seem to suggest that this is short-sighted. A vibrant and active free-choice learning sector is fundamental to a scientifically and technologically literate society. In fact, there is growing evidence to show that the more the three educational sectors of school, work and free-choice learning overlap in people's lives, the more successful people are at becoming lifelong science learners (Medrich, 1991; Hacker and Harris, 1992; Caillot and Nguyen-Xuan, 1955; Knapp, 1997; Anderson, 1999; Wright, *et al.*, 2001). Free-choice learning is not more important than schooling, but neither is schooling more important than free-choice learning. The goal of science education in the 21st Century must be support of lifelong science learning. Achieving this goal will require equal and complimentary support for the science learning that occurs in schools and universities, in the workplace and in the free-choice learning sector.

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