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## Public Understanding of Science

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### Synonyms

Public awareness of science; Scientific culture; Scientific literacy; Public relationship with science; Science engagement

### Definition

> All encompassing term that refers to a relationship between the general public and the scientific community regarding scientific knowledge, literacy, awareness, attitudes, and behaviors (Juan et al. 2014).

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### The Public Understanding of Science

#### Introduction

Science and technology (S&T) shapes the everyday lives of individuals. Therefore, there has been widespread recognition of the need to promote greater engagement between the public and the scientific community. The purpose of these engagements is to facilitate mutual understanding, sharing of information, and critical public participation in the future of S&T policy development and practice.

The nature of this relationship is influenced by the levels of education and development within each society, how "science" is defined, and the scope and scale of national science communication efforts. In order to identify ways of enhancing the relationship between the public and S&T, much research has investigated the public understanding of science.

#### Evolution of the Public Understanding of Science Frameworks

##### Scientific Literacy

The field of public understanding of science has evolved considerably over time. In the mid-1950s and early 1960s, science faced a *crisis of legitimacy* in the USA (Parker 2017). The economic and political pressures of the "space race" prompted scientists and policymakers in the USA to increase public support for science and technology projects through an increase in government

spending (Bauer et al. 2007; Juan et al. 2014; Laugksch 1996). At the same time, parents in the USA were concerned that their children were not equipped to function in an increasingly S&T-dependent society. Public support requires a critical citizenry that sees the value of S&T, and is able to engage in contemporary debates (Parker 2017). It was therefore necessary for the government to enhance the relationship between the general public and S&T. The concept of *scientific literacy,* first introduced by Jon Miller (1983), was defined to include three key dimensions: a) knowledge of scientific facts, b) understanding of scientific methods, and c) understanding of the relationship between science and society.

This model views the public as *deficient* in terms of their knowledge of S&T facts, methods, and policy issues, in comparison to the scientific community (Parker 2017). A scientifically illiterate public would therefore be unable to fully participate in effective decision-making, nor adequately appreciate S&T advances (Burns et al. 2003). This may result in the public having negative attitudes toward S&T, which could hinder S&T progress, and prevent the public from benefiting from S&T (Juan et al. 2014; Miller 1983). Miller (1983) posited that the scientific community are responsible for addressing the deficit in public scientific literacy, thus requiring a greater focus on educating the public (Juan et al. 2014; Laugksch 2000).

This model has however been criticized for only considering formal scientific knowledge and excluding informal, indigenous, or practical scientific knowledge (Bauer and Durant 1997; Raza et al. 2002). This "lack of cultural reflexivity" (Parker 2017) poses a problem in terms of sensitivity to accurately measuring scientific literacy in different social contexts, particularly in developing countries (Parker 2017; Raza et al. 2002). The model was also criticized as it assumes a positive relationship between knowledge and the public relationship with science, and does not allow for a negative relationship following knowledge acquisition (Parker 2017; Reddy et al. 2009).

## Public Understanding of Science

By the mid-1980s, S&T-related research and development (R&D) had developed a large private sector component, with significant amount of public-funded R&D projects under private control. As a result, information of state spending on S&T and public participation was generally low, leaving little room for public engagement (Gregory and Lock 2008; Juan et al. 2014).

Some scientists believed that the exclusion of the public from S&T issues was causing negative attitudes toward S&T, as well as a lack of public interest in science, which had weakened the influence of the scientific community and resultantly impacted government funding for S&T (Reddy et al. 2009; Miller 2001). In 1985, a report titled *The Public Understanding of Science* was published by the British Royal Society, outlining the essential elements of the relationship between the public and the scientific community (Parker 2017; Royal Society 1985). The report also raised concerns about the political vulnerability of the scientific community as a result of waning levels of public support for S&T (Miller 2001). Following this report, the *Public Understanding of Science (PUS)* emerged as a research paradigm within the field of study.

Although there are some overlapping characteristics between this model and that of the scientific literacy model, the PUS model focuses on understanding public attitudes and interest toward science, and how this relates to scientific literacy and its impact on the relationship between the public and science (Parker 2017). The model acknowledges the multidimensionality of the public's relationship with science, taking into account knowledge, attitudes toward, and interest in S&T as core elements (Laugksch 1996; Bauer et al. 2000; Bauer et al. 2007). The PUS model therefore proposes that a public deficient in positive attitudes to science may lead to a less than supportive funding and policy environment for scientists (Durant 1999; Parker 2017).

The proposed solution to this *deficit* is improved communication of scientific information to the public, as effective communication can promote more positive attitudes and greater interest in S&T (Gregory and Lock 2008; Reddy et al. 2009; Parker 2017), and a knowledgeable public would be more inclined to support S&T endeavors (Miller 2004; Parker 2017). As with the scientific literacy model, the *PUS* model

continues to engage the public with a single-direction flow of information, maintaining the existing power dynamic between the scientific community and the general public (Bauer et al. 2007; Parker 2017).

### Science and Society

During the mid-1980s, the European "mad cow disease" crisis, and the associated public panic, led to an awakening within the scientific community, which began to take many of the critiques of the previous two models into account (Jasanoff 1997). In the late 1990s, a new research paradigm emerged that recognized the value and importance of the public-science relationship (Pardo and Calvo 2002; Parker 2017).

In 2000, the British House of Lords Special Committee on Science and Technology published a report titled *Science and Society*, which declared a "crisis of public confidence in science" (House of Lords report 2000). The report highlighted that science is a socially constructed enterprise operating within a social context, yet it was often seen as separate from the broader public (Bauer et al. 2007; Parker 2017). The report emphasized that public attitudes are informed by a range of values, and the inclusion of this into research and policy was critical in order to increase public support for the enterprise (Parker 2017). This model reframed scientific advancement as a dialogue with the public, resulting in the emergence of a more "contextual approach" to S&T research, with knowledge flows becoming bidirectional, and the value of public opinion, indigenous knowledge, and social realities increasingly directing scientific work (Bauer et al. 2007; Reddy et al. 2009; Miller 2001; Parker 2017). Within this model, scientific literacy, attitudes, and interest are considered as aspects that impact the public relationship with science; while the social context in which the public is located as well as the social, cultural, and political influences that impact on the way they interact with the world are further critical aspects (Parker 2017).

According to Bauer et al. (2000), the deficit within the *science and society* model is of *public engagement* on the part of scientific actors and institutions (Bauer et al. 2000; Parker 2017). The shift in deficit attribution does not discount a public knowledge or attitude deficit, but rather redirects the responsibility of addressing that deficit to the scientific community (Miller 2001; Parker 2017; Raza et al. 2002). A key part of this model is therefore how science communication shapes science attitudes and dispositions of the public.

## Public Understanding Research Around the World

Countries around the world have investigated the public understanding of science based on the theoretical frameworks discussed. Some of these surveys have been conducted periodically, while others have been used as once-off data collection tools. Studies have been conducted in countries including the USA, the UK, Malaysia, Japan, Korea, China, Sweden, Germany, Spain, and South Africa (Table 1). Many of these studies have been undertaken to investigate public knowledge, attitudes, and interest in science, in order to allow for international comparison and to identify changes in national trends over time.

The Eurobarometer is a series of surveys which has been conducted regularly for the European Commission since 1973. The standard Eurobarometer is conducted annually, and investigates the opinions of the public in European Union Member States. Several Special Eurobarometer studies focused on science have been included periodically.

The USA's National Science Foundation (NSF) has released the Science and Engineering Indicators (SEI) biennially since 1979, which focus on science at all levels, including basic and higher education, the labor force, research and development as well as industry and technology. One of the elements reported on in the SEI relates to public attitudes toward, and understanding of, S&T. The most recent set of indicators (2022) explores indicators of public perceptions of S&T, familiarity with science research processes, sources of science information and involvement in scientific activities.

Public Attitudes to Science 2019 was the sixth in a series of studies investigating the UK public's attitudes to science, scientists, and science policy. It followed the 2000 Science and the Public, 2004 Science in Society, 2008 Public Attitudes to

**Public Understanding of Science, Table 1** International surveys conducted on the public understanding of science

| Context | Survey | Years |
|---|---|---|
| Brazil | Public Perceptions of Science and Technology | 2006; 2015 |
| Canada | Public Survey of Science Culture in Canada | 2013 |
| Canada and the USA | Canada-US Survey on Biotechnology | 2005 |
| China | Chinese National Survey of Public Scientific Literacy | 2001; 2007; 2010; 2015 |
| | China Science and Technology Indicators | 2004 |
| Europe | Eurobarometer European Science and Technology | 1992, 2005, 2010 |
| | Eurobarometer Europeans and Biotechnology in 2005: Patterns and Trends | 2005 |
| | Eurobarometer Scientific Research in the Media (2007) | 2007 |
| | Eurobarometer Attitudes Toward Radioactive Waste | 2008 |
| | Eurobarometer Europeans' Attitudes Toward Climate Change | 2008; 2019; 2021 |
| | Eurobarometer Europeans and Biotechnology in 2010: Winds of change | 2010 |
| | Eurobarometer: Responsible Research and Innovation (RRI) Science and Technology | 2013 |
| | Eurobarometer Public Perceptions of Science, Research, and Innovation | 2014 |
| | Public attitudes to life sciences research in six European countries | 2018 |
| | Attitudes of Europeans towards Air Quality | 2019; 2022 |
| | Attitudes on vaccination against Covid-19 | 2021; 2022 |
| | European citizens' knowledge and attitudes towards science and technology | 2021 |
| | Attitudes towards the Impact of Digitalisation on Daily Lives | 2020 |
| | Attitudes of Europeans towards the Environment | 2020 |
| | Attitudes of Europeans towards Biodiversity | 2019 |
| Germany | Wissenschaftsbarometer (Science barometer) | 2014; 2015; 2016; 2017; 2018; 2020 |
| India | India Science Report | 2005 |
| Israel | Science and Technology in the Israeli Consciousness | 2006 |
| | Perceptions and attitudes of the Israeli public about science, technology, and space | 2016 |
| Italy | Annuario Scienza Tecnologia e Società (Technology and Society Science Yearbook) | 2005–2022 |
| Japan | 2001 Survey of Public Attitudes Toward and Understanding of Science and Technology | 2001 |
| | Survey of Scientific Literacy | 2011 |
| Korea | Survey of Public Attitudes Toward and Understanding of Science and Technology | 2004; 2006; 2008; 2012 |
| Malaysia | Public Awareness of Science, Technology, and Innovation (STI) Malaysia | 1998; 2000; 2002; 2004; 2014; 2019 |
| Russia | Russian Public Opinion on the Knowledge Economy | 1996–2003 |
| South Africa | Understanding and appreciation of science among the public in South Africa | 1991 |
| | Understanding and appreciation of science among South African teenagers | 1993 |
| | Omnibus Survey | 1995 |

(continued)

**Public Understanding of Science, Table 1** (continued)

| Context | Survey | Years |
|---|---|---|
| | Test for Scientific Literacy and its application in assessing scientific literacy of matriculants entering universities and technikons | 1996 |
| | EPOP | 1999 |
| | Interests, Public Attitudes, and Sources of Scientific Information in South Africa | 2001 |
| | Public Understanding of Science in South Africa – aiming for better intervention strategies | 2001 |
| | The scientific and technological literacy of first-year physics students: the effects of a traditional school curriculum | 2001 |
| | Assessing Public Support for Biotechnology in South Africa | 2004 |
| | SASAS Biotechnology Survey | 2003, 2014 |
| | SASAS Climate Change/Global Warming | 2007, 2017 |
| | SASAS Energy | 2011, 2012, 2013, 2018 |
| | SASAS Environment | 2004, 2010, 2013 |
| | SASAS Indigenous Knowledge | 2009 |
| | The Public Understanding of Biotechnology in the Media | 2010 |
| | SASAS Public Relationship with Science | 2010, 2013; 2022 |
| | SASAS Nuclear Energy/Technology | 2011, 2013 |
| | SASAS Astronomy and SKA | 2013 |
| | Development of Indicators for the Measurement of the South African Publics' Relationship with Science | 2017 |
| | Fourth Industrial Revolution | 2018 |
| Spain | Percepción social de la ciencia y la tecnología (Social Perception of Science and Technology in Spain) | 2002, 2004, 2006, 2008, 2010, 2012, 2014, 2016, 2018 |
| Sweden | VA (Vetenskap & Allmänhet [Science & Public]) Barometer | 2002; 2006–2019; 2021 |
| UK | Science in Society | 2005 |
| | Public Attitudes to Science 2008 | 2008 |
| | Wellcome Trust Monitor: Tracking public views on medical research | 2009 |
| | Wellcome Trust Monitor Wave 2: Tracking public views on science, biomedical research and science education | 2013 (conducted 2012) |
| | Wellcome Trust Monitor Report Wave 3: Tracking public views on science and biomedical research | 2016 (conducted 2015) |
| | Public Attitudes to Science (Ipsos MORI) | 2011 |
| | Public Attitudes to Science 2014 (Ipsos MORI) | 2014 |
| | Public attitudes to chemistry | 2015 |
| | Public Attitudes to Science 2019 (Ipsos MORI) | 2019 |
| USA | Science and Engineering Indicators | 1979–2022 (every two years) |
| | Various surveys (Gallup Organization) | 1982–2017 |
| | Media and political surveys (various) (Pew Research Center for the People and the Press) | 1985–2016 |
| | Biennial News Consumption Survey | 1996–2008 |
| | National Assessment of Education Progress (NAEP) | 2000; 2005 |
| | Virginia Commonwealth University (VCU) Life Sciences Survey | 2001–2008 |
| | Pew Internet and American Life Project Survey | 2006; 2012 |
| | General Social Survey (GSS) S&T module | 2006; 2008; 2010; 2012; 2014; 2016 |
| | News Interest Index | 2007–2008 |

(continued)

**Public Understanding of Science, Table 1** (continued)

| Context | Survey | Years |
|---|---|---|
| | American Association for the Advancement of Science (AAAS) Project 2061 | 2007 |
| | CBS News/New York Times Poll | 2008 |
| | Project on Emerging Nanotechnologies (2008) | 2008 |
| | Climate Change in the American Mind | 2008–2016 |
| | National Surveys on Energy and Environment | 2009–13, 2016–17 |
| | American Belief in Climate Change | 2012 |
| | General Public Science Survey, separate survey of American Association for the Advancement of Science members | 2014 |
| | Perceptions of Science in America | 2018 |
| Various countries | Programme for International Student Assessment (PISA) | 2000/2002; 2003; 2006; 2009/2010; 2012; 2018 |
| Various countries | Relevance of Science Education (ROSE) | |
| 15 countries | BBVA Foundation International Study on Attitudes Toward Stem Cell Research and Hybrid Embryos | 2007/2008 |
| Various countries | BBVA Foundation International Study on Scientific Culture | 2011 |
| Various countries | Global Attitudes Survey | 2013 |
| Various countries, including SA | Wellcome Global Monitor: How does the world feel about science and health? | 2018 |
| Various countries, including SA | 3M State of Science Index Global Report | 2018; 2019; 2020; 2021; 2022 |
| Various countries, including SA | Trends in International Mathematics and Science Study (TIMSS) | 1995, 2003, 2011, 2015, 2019 |

Note: This list is not exhaustive, but provides an overview of what has been done.

Science, 2011 Public Attitudes to Science and the 2014 Public Attitudes to Science studies. A representative survey of UK adults aged 16+ were included in the study, which used a mixed methods approach to understand how the public engages with science, in online and offline settings. The later editions in the PAS series further explored public attitudes to emerging technologies in response to the social influence of big data, artificial intelligence, and energy technologies.

In the developing country context, India set the standard for the measurement of the public's relationship with science with their comprehensive 2005 India Science Report. The report was commissioned in 2004 by the National Council of Applied Economic Research (NCAER) to assess the country's readiness to overcome the challenges associated with the introduction of a knowledge economy, and to take advantage of its associated opportunities. The survey was administered to over 30,000 members of the general public over the age of 10 years. One element of the survey focused on public attitudes toward S&T, and asked questions related to S&T information, interest in S&T issues, and knowledge of S&T. The survey included items from the NSF and Eurobarometer, as well as a set of items adapted to the context of the country. Unfortunately, this survey has not been repeated.

Malaysia conducted a biennial study between 1998 and 2004, and again in 2014 and 2019, on the Public Awareness of Science, Technology, and Innovation (STI). The various surveys addressed

public knowledge, attitudes, interest, awareness, and sources of information, as well as visits to science engagement institutions.

The State of Science Index which has been conducted annually since 2018 in various countries across the world is third-party research that explores global attitudes about science. The survey was commissioned by the organization 3M to examine perceptions of science and its positive or negative impact on society. It also captures sentiment toward science, through measures of appreciation, popularity, interest level, and trust versus skepticism.

In South Africa, research on the publics' relationship with science has produced a large, yet disjointed set of outputs, from the early work of Pouris (1991; 1993; 2001; 2004) to the more recent work of the Human Sciences Research Council (1995; 1999; 2004; 2007; 2010; 2013; 2017; 2018; 2022) using the South African Social Attitudes Survey (SASAS). The practice of research within this field has evolved within the theoretical advances as well as the social transformation toward democracy in South Africa. The work by Reddy et al. (2009), undated in 2020 (Reddy et al. 2020), produces a more nuanced picture of the public understanding of science. A nationally representative survey implemented by Parker (2017) investigated a number of concepts related to public knowledge, attitudes, interest in and *informedness* about science, as well as sources of information and attendance at science engagement centers among the South African public. The first full survey on PRS is being conducted in South Africa in 2022?

A few studies have also been conducted at the school level, such as the Relevance of Science Education project (ROSE), some of the items in the Program for International Student Assessment (PISA), and some items in the Trends in International Mathematics and Science Study (TIMSS). These provide internationally comparative data related to students' perceptions of the important factors affecting S&T education. The results of these studies have been used to make recommendations regarding the understanding of science among both the general public and students, and how a better relationship between science and society can be developed through policy changes and targeted interventions.

### Formulating a Public and Science Research Agenda

In the formulation of a public and science research agenda, it is important to remain cognizant of the bidirectional relationship between science and society. Science engagement is the dominant discourse and framework, and the need for two-way interactions has been highlighted. Other aspects that are important are: (i) the diverse nature of societies and the notion of multiple publics; (ii) the attitudes, values, knowledge, and behaviors of the public in relation to S&T; (iii) the contribution of indigenous knowledge systems; (iv) the importance of communication and appropriate messaging, including the influence of social media and technology on PUS and awareness programs; (v) citizen research as bidirectional learning opportunities; and (vi) the creation of science engagement platforms.

This framework would consider both science and the public as important stakeholders in the relationship, and acknowledges that each affects the other, rather than previous frameworks which gave science a position of power and perceived the public to be more or less deficient. This approach encourages greater engagement between science and the public, opening more effective dialogue spaces for mutual learning and social development opportunities.

## Cross-References


- ▶ Attitude Measurement
- ▶ Attitudes Toward Science and Technology
- ▶ Democracy
- ▶ Education
- ▶ Eurobarometer
- ▶ Health Care
- ▶ Indigenous Knowledge
- ▶ Science and Engineering Indicators

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