THE SOCIOLOGY OF TRUST IN SCIENCE

Evaluating and Predicting Levels of Scientism in Indiana Residents

Abstract

While science is traditionally regarded as an enterprise based on evidence, objectivity, and empirical data, its image in the eyes of the general population depends largely on trust. Most nonscientists do not have the expertise to understand specialized scientific evidence. Without the ability to engage with scientific knowledge firsthand, individuals may reject scientific claims based on their trust or distrust of science, especially if that claim contradicts their thinking. Therefore, interpretations of science and its role as a credible decision-making cue vary among individuals. The objectives of this research were to evaluate levels of scientism, or public trust in science, in Indiana residents and to develop and test an empirical model to identify the factors predictive of this trust. Indiana residents were found to have high levels of scientism, with nearly 90% of respondents agreeing that they would be willing to accept new ideas if provided with sufficient scientific proof. Among the explanatory variables assessed, institutional trust and interest in science/technology had a significant positive association with scientism, while religiosity had a negative association. Respondents who identified as male were also associated with higher levels of trust in science. The model explained 23.2% of the variance, leaving over three-quarters of the variance unexplained. These findings demonstrate that trust in science can be explained not by one particular factor but rather by a complex range of underlying attributes. Results also indicate that dialogue with religious publics and building and maintaining credibility are important dimensions to consider in effective science communication and engagement.

Keywords

scientism, sociology of science, science communication, science perceptions, trust, public acceptance

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INTRODUCTION

New scientific discoveries and technologies have shaped every aspect of humankind to extend and advance our capacities, from improving physical strength to extending intellectual abilities. But even though science is everywhere, it has become a highly polarizing concept. For some, it may seem like science is progressing too fast. For others, science may contradict their deeply held beliefs and values. There are concerns about the role science should play in our lives and about the legitimacy of science and scientists themselves. Understanding public acceptance of science requires further investigation of the factors that may shape one's trust in science. Issues of public opinion and trust of science are formed in hundreds of local communities, such as in the one pictured in Figure 1.

Science is traditionally regarded as an enterprise based on evidence, objectivity, and empirical data. But for the general population, science may actually be based on trust (Lisle, 2020). The construct of *scientism* is considered as a measure of trust, or faith, in science as the best or only factor in access to the truth and in decision making (Mehta, 2001). Most people do not have the specific expertise to understand specialized scientific evidence because it often requires cognitive approaches and knowledge of terms unfamiliar to nonscientists (Rutjens, Heine, Sutton, & van Harreveld, 2018). In addition, firsthand observation of scientific discoveries is difficult without access to technical equipment and specialized disciplinary knowledge (Hendriks, Kienhues, & Bromme, 2016). Without the ability to engage with scientific knowledge firsthand, individuals may reject scientific claims based on a lack of trust, especially for science that is counterintuitive. Because of this reality, interpretations of science and its perceived role as a credible decision-making cue vary among individuals.

Predominant approaches to scientific communication challenges, such as the information deficit model, are often ineffective. In this approach, it is assumed that increased knowledge about scientific topics will influence public attitudes and behaviors, which will improve the "health of the scientific enterprise" (Dudo & Besley, 2016, p. 2). While the ability to understand scientific information is important, it is not central to reducing risk perceptions (Slovic, 2006). According to Slovic, lay

FIGURE 1. Public opinion refers to the values, attitudes, beliefs, and views that are shared by a community, such as this one in Indiana. Image courtesy of Purdue University College of Agriculture.

risk judgments are not irrational. Rather, they are influenced by other factors in a way that is “both simple and sophisticated” (2006, p. 689). Further studies consistently conclude that there is a weak association between increased scientific knowledge and increased trust in science, or scientism (National Academies of Sciences, Engineering, and Medicine, 2018).

The rejection of science and the scientific method goes beyond educational and cognitive constraints of individuals and may be more significantly shaped by how people think of knowledge (Rutjens et al., 2018). Conceptualizing trust in science requires further attention to the belief system of scientism, in which individuals believe that the scientific method is the best way to access truth. Because understandings of science and knowledge are so personal, levels of scientism vary among individuals possibly due to of attitudinal and sociodemographic underpinnings.

The goal of this research is to measure and evaluate the levels of scientism in Indiana residents as well as investigate variables predictive of scientism. An empirical model was developed and tested to identify the strength of these variables using scientism as a dependent variable. Using data collected from a larger study on Indiana residents’ perceptions of science, the results of this research could help inform educators, science communicators, scientists, and others about how perceptions of science are shaped in Indiana.

LITERATURE REVIEW

The construct of scientism was first articulated during early discourses about the philosophy of science. One of the earliest recorded definitions describes scientism as an intellectual attitude in which “the scientific method is the only path to the attainment of truth,” as opposed to other

sources of knowledge such as religion or intuition (Elkus, 1909, p. 51). For the purposes of this study, scientism is considered one's trust in science. Higher levels of scientism are likely indicators of the degree to which one might use scientific evidence when making a decision. (Mehta, 2001; Knies, 2019).

A helpful tool for understanding risk perceptions is cultural values, which can be measured using grid-group cultural theory. Cultural theory provides multidimensional information about how humans perceive and understand the world around them (Coughlin & Lockhard, 1998; Mamadouh, 1999). There are two dimensions that structure the theory, each of which exist on its own spectrum. Axes of the two dimensions establish four distinct cultural types: hierarchy, egalitarian, communitarian, and individualist (Figure 2). These social types can be thought of as cultural outlooks that shape understanding of risk and science (Mamadouh, 1999; Knies, 2019).

Similar to cultural worldviews, religiosity also comprises a major portion of one's ideological convictions. Throughout history, science and religion have had a tense relationship. Both offer ways and answers for understanding the visible and invisible world (Rutjens et al., 2018). While the two institutions can be contradictory at times, they are not mutually exclusive. Scholars have argued that these two belief systems "cover different domains of knowledge," and that "science is based on having faith in observation, while religion is based on having faith in that which transcends observation" (Rutjens, et al., 2018, p. 133). Tension between these constructs also exists due to morality. Certain scientific concepts may conflict with firm religious values such as genetic engineering, which can be seen as "playing God" (Rutjens et al., 2018; Mehta, 2001). In a National Opinion Research Center study, religiosity was found to be significantly associated with more negative attitudes toward science, even when demographic variables were controlled (McPhetres, Jong, & Zuckerman, 2020).

Adapted from Kahan, 2012; Mamadough, 1999; & Knies, 2019

FIGURE 2. Cultural cognition of risk. The figure displays two dimensions that structure grid-group cultural theory. Axes of the two dimensions establish four distinct cultural types: hierarchy, egalitarian, communitarian, and individualist.

Mass media has radically altered science communication processes. Social media and online news sites are increasingly important information sources, which can encourage more informed citizens but also incidences of clickbait and fake news. Mass media dependency theories assert that the information that media provides may amplify or shape individuals' risk perceptions (Wachinger, Renn, Begg, & Kuhlicke, 2013). The theory posits that mass media is more important to those who depend on it, and therefore those people are more susceptible to the effects of media in telling them what to think about (e.g., agenda setting) and even how to think (Ball-Rokeach & DeFleur, 1976). In a survey conducted by the Pew Research Center (2017), about 73% of respondents blame communication issues for the way media covers scientific research, while 24% of respondents blame the way researchers disseminate their findings.

Level of interest and awareness in scientific topics may also influence levels of scientism. For instance, those who are more engaged with genetically modified foods tend to trust scientists' ability to understand their health risks and benefits. In addition, respondents with high science knowledge are more likely (41%) to perceive greater benefits from genetically modified foods compared to those with low science knowledge (11%) (Pew Research Center, 2016).

Trust in science also varies among sociodemographic variables such as education, race, sex, age, and income, although the influence of these variables is inconsistent across studies. One of the more consistent variables is education, which has been found as a significant factor of trust in science in a few studies. For instance, a predictive model for trust in scientists estimated that a respondent with "no formal education" in science would have a trust in scientists score of 2.8, while a respondent with "up to college" education in science would have a 3.1 score, with 4 representing the maximum level of trust (Wellcome Global Monitor, 2018).

Many of these demographic variables may be interconnected. For instance, about 28% of African American adults in the United States reported having a "great deal" of confidence in the leaders of the scientific community compared to 43% of white adults reporting the same amount of confidence. This gap in trust may be due to the

disparity between educational opportunities and experiences within nonwhite populations, but there may also be additional cultural elements at play (National Academies of Sciences, Engineering, and Medicine, 2018).

Across studies, women are consistently more likely to be risk-averse than men (Mehta, 2001). In a randomly sampled U.S. study, about 37% of women reported a "great deal" of confidence in science compared to 45% of men (National Science Board, 2016). While women may perceive greater risks in science, this does not mean that they do not trust science. For instance, in a Canadian study, women reported significantly more favorable attitudes about science's ability to improve quality of life (Roberts, Reid, Schroeder, & Norris, 2011). The significance of gender in predicting levels of scientism is inconclusive, and further analysis is needed.

Akin to gender, age has not been a consistent predictor of scientism across studies. In a U.S. public opinion survey, 48% of respondents aged 18–34 had a "great deal" of confidence compared to 40% of respondents aged 35–49, 37% of respondents aged 50–64, and 35% of respondents aged 65 or higher (National Science Board, 2016). However, other research has shown that older respondents and subsequently those with more education, income, and scientific knowledge are more likely than younger respondents to trust science (National Academies of Sciences, Engineering, and Medicine, 2018).

Finally, the role of household income in public perceptions of science has also been disputed. In a study investigating perceptions about the speed of the scientific enterprise, less income and less education were associated with higher concern about changes in science and technology (National Academies of Sciences, Engineering, and Medicine, 2018).

METHODOLOGY

This research was part of a larger study on Indiana residents' perceptions of emerging science and technology and perceptions of Purdue University. Data were collected through a statewide mail survey of 4,500 Indiana households. Researchers chose mail survey methodology because it was the most accurate way to

FIGURE 3. Number of survey respondents by Indiana county ($n = 1,003$) (Rice, 2019). The chart displays the number of survey respondents by Indiana counties. Each county is color-coded to the number of surveys returned.

sample a statewide population and estimate response and sampling error. The households were selected through stratified random sampling, as the larger study required an oversampling of rural households to ensure adequate rural response for purposes outside of the current study. Just over 1,000 surveys were returned, with a 26% response rate from 87 of 92 Indiana counties, as shown in Figure 3 (Rice 2019).

During the analysis, data were weighted so that the descriptive and multivariate statistics would be representative of the population parameters of Indiana. In addition, the data needed to be weighted to compensate for a high median age and the oversampling of rural households.

The survey questionnaire was developed by several graduate students and a faculty member in the

department, a research methodology consultant from the National Opinion Research Center at the University of Chicago, and a graphic design consultant. The final instrument was 12 pages long and contained 132 questions (Knies, 2019).

The analysis used eleven independent variables measured by either single-item indicators or multiple-item (scale) indicators. Single-item variables included age, sex, race, education, income, and level of interest in science and technology. Scale variables, with the reliability coefficient in parentheses, included media system dependency (0.71), source trust (0.75), individualist cultural theory (0.70), hierarchy cultural theory (0.79), and religiosity (0.92).

Graduate students in the department developed a coding sheet to guide entry of data into IBM SPSS Statistics. To test the model, a special software module called SPSS Complex Samples was used. Variance in the dependent variable, scientism, was regressed against variance in the explanatory variables. Prior to this procedure, a correlation matrix of the independent variables was inspected for multicollinearity, which refers to a condition in which multiple independent variables are highly related. No instances of excessive multicollinearity were found. A p -value of 0.05 was specified a priori to determine statistical significance.

RESULTS

Table 1 describes key sociodemographic characteristics for the 1,003 adult respondents. Over half of the respondents were female (53.7%). Respondent ages ranged from 18 to 99, with a weighted mean of 49 years. A majority of respondents (62.7%) had completed some form of postsecondary education. Subjects were predominantly white (88.7%). Respondents reported incomes ranging from \$15,000 to \$350,000, with a median range from \$50,000 to \$75,000. Nearly all respondents (95%) reported having Internet access either through a home internet provider or mobile phone.

The dependent variable in the study was scientism, which was measured through a scale item adapted from Johnson (2017) and Macnaghten and Chilvers (2014).

TABLE 1. Subject characteristics.

Sex	Female 53.7%	Male 46.3%		
Age (mean)	49 years			
Educational attainment	Less than high school	3.0%	High school/GED	16.3%
	Vocational/trade	7.1%	Some college	17.9%
	Associate of arts/science	9.0%	Bachelor of arts/science	30.0%
	Master's/PhD	16.60%		
Race/ethnicity	White 88.7%	Black/African American 5.5%	Hispanic/Latino 3.2%	Asian 1.9%
Gross household income (median range)	\$50,000 to \$75,000			
Home or mobile phone Internet access	95%			

Weighted population estimates presented in percentages, and mean population estimate provided for age variable (n = 1,003) (Knies, 2019).

TABLE 2. Descriptive findings of scientism.

	Percentages							
Statements	Strongly Agree	Somewhat Agree	Neither Agree nor Disagree	Somewhat Disagree	Strongly Disagree	N	Mean¹ (SD)	Mean Pop. Estimate² (SE)
I am willing to accept new ideas if provided with sufficient scientific proof	39.4	50.3	7.3	2.3	0.7	987	4.22(0.74)	4.25(.03)
Science is more constructive than destructive	26	46.9	22.6	3.2	1.1	986	3.90(0.85)	3.93(.04)
Science creates more problems than it solves ³	1.5	11.2	33.4	35.6	18.3	987	3.53(0.97)	3.58(.04)
Science can eventually solve most of the problems facing the world	14.2	43.3	20.9	14.3	7.3	988	3.34(1.11)	3.43(.05)

Respondents' level of scientism, weighted population estimates presented in percentages, number of respondents, unweighted mean, and mean population estimate (n = 1,003) (Knies, 2019).

¹ Unweighted mean (standard deviation). Items scaled 5 to 1, strongly agree to strongly disagree.

² Mean population estimate (standard error).

³ Item scaled 5 to 1, strongly disagree to strongly agree.

Using a Likert-type 5-point scale, we asked subjects to specify their level of agreement with the statements in Table 2. The statement "Science creates more problems than it solves" was recoded so that higher values correspond to greater levels of scientism. The alpha coefficient calculated for reliability for the four statements was 0.68. The alpha was slightly below the recommended 0.70 threshold but was deemed acceptable in the current work

because of its face validity as well as its application in other research.

Descriptive findings for scientism indicate that Indiana residents have relatively high levels of scientism. Nearly all respondents (90%) agreed that they would be willing to accept new ideas if provided with sufficient scientific proof. Just under three-fourths of respondents (72.9%)

agreed that science is more constructive than destructive. However, respondents had mixed feelings about whether science creates more problems than it solves, as one-third (33.4%) of subjects neither agreed nor disagreed with the statement.

Descriptive Findings of Independent Variables

Subjects were asked a series of questions to determine their position on two cultural worldviews: individualist/communitarian and hierarchy/egalitarian. More than 60% of the respondents agreed with the statement that the government should stop telling people how to live their lives and that the government interferes too much in everyday lives, indicating a strong individualist ideology. A majority of subjects agreed with the statement that some groups in society don't want equal rights—they want special rights just for themselves—and that society as a whole has become too soft, indicating a strong hierarchy ideology.

The questionnaire included four statements to measure subjects' level of religiosity. Nearly three-fourths of the respondents reported that they believe in the power of prayer.

To measure media system dependency, we asked respondents to rate the helpfulness of various social media and mass media platforms for receiving information to stay informed and make decisions. Respondents had relatively high levels of media system dependency for both online and traditional media sources. Respondents rated internet news sites as the most helpful, followed by radio and newspapers. Twitter and Facebook were rated as the least helpful media platforms for receiving information.

Respondents were also asked to report their level of trust in various information sources. Farmers, university scientists, and friends and family were rated most trustworthy, while government agencies, news organizations, and the food industry were rated least trustworthy.

Respondents were asked to self-rate their interest and awareness in emerging science and technology. Nearly two-thirds of the respondents (63.2%) indicated that they were moderately or very interested in the topic;

TABLE 3. Multiple linear regression analysis for scientism.

Predictor Variable	B	SE	t	p
Institutional trust	0.253	0.050	5.041	0.000*
Religiosity	−0.116	0.023	−4.989	0.000*
Interest in science and technology	0.584	0.239	2.444	0.015*
Sex	−0.494	0.213	−2.315	0.021*
Media system dependency	0.040	0.022	1.833	0.067
Education	0.108	0.060	1.788	0.074
Income	0.048	0.069	0.691	0.490
Individualism-communitarianism worldview	−0.021	0.038	−0.556	0.578
Hierarchy-egalitarianism worldview	0.015	0.030	0.511	0.609
Race	−0.146	0.415	−0.352	0.725
Age	−0.006	0.080	−0.075	0.940
Model R-Square	0.232			

Variance in scientism regressed against variance in the explanatory variables. This table presents model estimates, standard error, t-statistic, and significance.

*Coefficient is significant at the 0.05 level.

however, less than half (45.1%) reported themselves as very or moderately aware (Table 3).

A multiple linear regression analysis was used to test the theoretical model developed for this study. The model indicates the explanatory variables most predictive of scientism, with an asterisk indicating statistically significant relationships. As the Beta coefficients are not standardized for this model, they cannot be compared to each other based on their magnitude to assess the strength of their relationship with the dependent variable. Instead, the t-values and probability levels were considered, as they provide information on the relative strength and significance of each independent variable (Knies, 2019). Institutional trust and religiosity were found to be the strongest predictors of scientism, trailed by interest in science/technology and sex. The remaining independent variables did not enter the model, which means they do not have a statistically significant relationship with scientism in this context. The Beta coefficients indicate the direction of the relationships of the

explanatory variables. The model explained about 23% of the variance, which leaves nearly 75% of the variance unexplained.

DISCUSSION

An empirical model was developed and tested with the objective of identifying sociodemographic and attitudinal factors predictive of scientism. Utilizing SPSS Statistics, we used multiple linear regression to test the strength of the model. The results indicate that the model was somewhat successful, as it explained almost one-fourth (23.2%) of the variance in scientism. Four of the 11 variables—institutional trust, religiosity, interest in science and technology, and sex—entered the model as statistically significant. The other 7 variables—hierarchy-egalitarian worldview, individualist-communitarian worldview, media system dependency, education, income, race, and age—failed to enter the model. These variables are still important to investigate in future studies despite their nonsignificance in the current work. With over 75% of the variance left unexplained, additional work is needed for improved model specification and measurement to enable a greater understanding of the factors predictive of scientism.

Nevertheless, the model provided key insights into the trust of science within Indiana residents. First, the model suggested that institutional trust is the most powerful predictor of scientism. Institutional trust refers to trust in government agencies, news organizations, university scientists, and environmental groups. The positive Beta coefficient indicates that greater institutional trust is associated with higher levels of scientism. This result demonstrates that building and maintaining credibility is important for scientists and science-based institutions. Maintaining trust may be increasingly difficult, as institutions may underestimate deep ideological divisions in Indiana and in the United States.

Trailing slightly in significance was religiosity, which had a negative Beta coefficient. The model indicates that higher levels of religiosity are associated with lower levels of scientism, that is, there is a negative correlation between religious beliefs and science. This finding demonstrates that dialogue with religious publics is an important dimension to consider in effective science

engagement. Effective science communication must include a methodology to better understand and address tensions that exist between deeply held religious beliefs and certain scientific topics.

The model showed that interest in science and technology was positively correlated with higher levels of scientism. Previous research has shown that sparking early interest in science in youths is associated with greater adult trust of climate scientists (Motta, 2018). These findings suggest that early introduction of STEM topics may encourage greater trust of science in adulthood, which would be beneficial to the health of the scientific enterprise. However, it is important to be cognizant that education alone will not dispel antiscience beliefs and also be cognizant of the disparities that exist in access to and quality of early education opportunities.

As for sex, the model revealed that men expressed higher levels of scientism than women. Some have theorized that differences in risk perceptions between men and women are due to biological and social factors. Slovic (1999) proposed that women have biologically evolved to give birth, nurture, and maintain life, and thus they may be inherently more concerned about human health and safety. But risk perceptions are not necessarily equivalent to trust in science, and there is no single clear explanation behind this finding.

While this project was successful, there were still a number of limitations. For instance, this research treated science as a singular concept that can be either trusted or distrusted, but the reality is that attitudes toward science are conditional. Certain science-based topics, such as vaccination safety and climate change, evoke different opinions of science. The metrics to measure scientism considered only the general scientific enterprise, and it is possible that this creates a threat to internal validity. In addition, the results from this study are not generalizable beyond its study population of Indiana.

Ultimately, the findings demonstrate that there is no single antiscience population, because public acceptance and trust of science are explained not by one particular factor but instead by a range of factors. For instance, each individual pictured in Figure 4 conceptualizes and negotiates the concept of science differently. The model indicates that increased education or knowledge alone

FIGURE 4. Perceptions of science are highly individualized and diverse, even among a specific population of people. Image courtesy of Purdue University College of Agriculture.

will not increase trust in science, as education did not enter the model as statistically significant. Furthermore, the term “antiscience” is very nuanced and complex. There is not a binary division between proscience and antiscience perspectives; instead, one’s understanding and trust of science lies on a multidimensional continuum. People may cherry-pick scientific findings that reinforce their currently held beliefs and reject those that contradict their beliefs, but rarely do people reject science completely. Ultimately, trust in science is highly complex, dependent on the topic or domain being studied and heavily influenced by the cultural context in which the research is conducted.

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