PREDICTING SCIENCE LITERACY AND SCIENCE APPRECIATION

by

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Abstract

Research has shown that the benefits of having a populace literate in science are great. Even if citizens are not literate in basic science, it is important that citizens still appreciate science and those with expertise in the field for many reasons. Recent research suggests that the United States (U.S.) has lower levels of science literacy than it should. Evidence may also suggest that many U.S. citizens are not appreciative of science. Overall, little research has been conducted on what may predict science literacy and science appreciation which is the aim of this research. Specifically, I have examined socio-personal variables, beliefs, thought paradigms, and various demographic variables that may be predictive of science literacy and science appreciation. Results indicated that scriptural literalism, religiosity, and magical ideation were predictive of low levels of science literacy. In addition, predictors of low levels of science appreciation included scriptural literalism and magical ideation. Implications of the findings are discussed.

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Introduction

In a nation that has a strong structural basis in science, it is greatly beneficial for the general public to be scientifically literate, or at least appreciative of science and those who have expertise in the field. We encounter science on an everyday basis, yet we face a potentially grave predicament that may eventually harm the nation if not addressed: it appears that much of the population has little knowledge of how science works (Impey *et al.*, 2011). Science is being chosen less frequently as an academic focus in the United States (U.S.) and evidence suggests that there has been no noticeable improvement in science literacy of undergraduate college students in approximately twenty years (Impey *et al.*, 2011). Cross-national studies have shown that in comparison to other developed nations, the U.S. population has relatively low levels of scientific literacy (Baldi et al., 2008; Bybee, 2008; Bybee, McCrae, & Laurie, 2009; Cromley, 2009). Additionally, evidence soon to be discussed suggests that U.S. citizens are not particularly appreciative of science, which may be reflected by the policy-makers in the U.S. government.

There is inconclusive research conducted on variables that may correlate with and/or predict science appreciation and literacy, which is the focus of this study. For example, in a twenty year study conducted at the University of Arizona, researchers were unable to identify any variable predictive of science literacy other than gender, whereby men performed only slightly better than women on a knowledge-based science literacy assessment. However, this gender difference was not statistically significant (Impey *et al.*, 2011). If we could discover whether certain sociopersonality traits, beliefs, and/or sociodemographic variables predict science literacy and appreciation, it may then be possible to develop ways to increase scientific literacy and appreciation.

Science literacy is a term that has been described in many ways, but despite its various definitions, there seems to be a consensus that the real-world ramifications of science literacy are of great importance (Bybee, 1993; Deboer, 2000; Maienschein, 1998; Millar, Nott, & Osborne, 1998; Rutherford & Ahlgren, 1990). Some examples of real-world implications of science literacy include evaluation of scientific evidence relayed by the media for accuracy and credibility, recognizing the importance of science in our society, as well as interpreting quantitative data (Cook, 1977; Koballa, Kemp, & Evans, 1997; Kutner *et al.*, 2007; Ryder, 2001; Uno and Bybee, 1994). In times when disagreement is high in regards to controversial, science-based issues that are critical to our wellbeing, such as global climate change, modern medicine, educational curricula, et cetera, the importance of having a scientifically literate and appreciative populace is paramount.

For a nation to make logical, informed decisions, it must be fluent in evidence-based reasoning such as that which is integral to scientific methodology to distinguish speculation from fact (Impey *et al.*, 2011). Moreover, a population literate in science would significantly improve policy-making decisions in a nation (Bodmer, 1985). This is because whether or not there may be a clear-cut, correct decision to make, at least the decision concluded upon would be rationally based in evidence (Bodmer, 1985). In our political system in the U.S., public understanding of science is absolutely necessary to make appropriate science policy decisions (Miller, 1983). Educators and researchers likewise also have concluded that ubiquitous science literacy at even a basic level is highly beneficial to national decisions made on health as well as other policies that relate to science (Bybee, 2008; Cromley, 2009; Eisenhart, Finkel, & Marion 1996; Laugksch, 2000; Miller, 1998; Rutherford & Ahlgren, 1991). In addition, it has been shown that science and technology are essential to economic growth and development (Bloch, 1986; Drori, 2003; Lewis, 1982; Walberg, 1983), but without a public appreciation for scientific endeavors, public funding for science is unlikely (Laugksch, 2000), and it is already quite minimal. In the 2015 fiscal year, less than 4% of the total federal budget was requested for research and development (R&D), and out of that portion, approximately half of the federal appropriation for R&D was designated to the Department of Defense (DOD) (Sargent Jr., 2014). So excluding funds designated to the DOD, R&D was appropriated less than 2% of the total federal budget (Sargent Jr., 2014).

It is especially important in these times that U.S. citizens understand science or at least appreciate and value advice from those with scientific expertise from a political standpoint. This is because a miniscule 5% of the members of the 113^{th} Congress have any background in science, and a majority are health care specialists (Manning, 2014). Approximately 2% of members of the 113^{th} Congress have scientific backgrounds in fields unrelated to healthcare; most of those members are in the House of Representatives, and only one member is in the senate (Manning, 2014). There was a time when a nonpartisan office of Congress known as the Office of Technology Assessment (OTA) existed to provide objective, scientific advice to the rest of the federal policy-makers of the U.S. in regards to complex scientific issues, policies, new technology, and more (Sadowski, 2012). However, this office was defunded and abolished in 1995 during Newt Gingrich's Republican ascendancy in Congress as it was deemed a nonessential use of taxpayer funds (Sadowski, 2012). During the OTA's 23 brief years of existence which began in 1972, it had produced over 700 studies on many pressing issues and diverse topics such as national security, healthcare, climate change, acid rain, various social issues, and so on (Sadowski, 2012). However unfortunate the demise of the OTA may be, the onus of responsibility has shifted to the general public to make informed decisions on scientific issues. This means that either the U.S. must improve its scientific literacy or must at least learn to appreciate the advice and opinions of those with scientific credibility.

Due to the internet, we currently have vast accessibility to information on an infinite amount of topics that has never been so easily and immediately available. Scientific information is not only available to scholars and researchers, but also is easily obtainable by the general population as well. Pew Research Center found that 86% of all U.S. adults report using the internet (Smith, 2014). In addition, it was discovered by the National Science Board that approximately half of all Americans used the internet as a primary source of information in 2012. Even though the availability to scientific information is high and the internet has been utilized by the masses to access it, evidence would suggest it has been used in an inappropriate and inefficient manner. For example, it has been reported that very few internet users check the sources and dates of the information they find (Fox, 2006). This may reflect poor national scientific literacy in regards to identifying credible scientific sources.

Even most formal academic institutions have failed to incorporate evaluating information found on the internet into their curriculum (Kuiper, Volman, & Terwel, 2005). It has been shown that undergraduate college students rarely search beyond the first site they find that has the information they need (Brem, Russell, & Weems, 2001). When undergraduate students were asked to rank the validity of internet sources they performed poorly (Britt & Anglinskas, 2002; Walraven, Brand-Gruwel, & Boshuizen, 2009) and frequently had difficulty recognizing credibility issues such as identifying conflict of interest, affiliation, and expertise in sources of evidence (Gormally, Brickman, & Lutz, 2012). When students are researching a topic they are not knowledgeable in, they are more likely to trust sources with low credibility and have difficulty determining which information is relevant to their work (Braten *et al.*, 2011). It has been discovered that in many cases students believe that the greater the number of authors on a publication results in a greater credibility of the source discovered (Brem *et al.*, 2011). All of these research fallacies suggest poor science literacy even in academic settings.

Thus far, little research has been conducted on variables that may predict science literacy. It was recently found that religious affiliation was negatively associated with science literacy (Sherkat, 2011). However, in this study science literacy was measured using a factual knowledge-based assessment. Some questions pertained to very specific information that would be unnecessary for most of the general public to know (e.g., the temperature of the core of the earth), and other questions that blatantly contrasted core religious beliefs (e.g., whether or not the universe originated from a huge explosion). This study did not measure science literacy as a way of thought, but more so as a body of knowledge. In a 20 year study conducted by Impey in 2011 at University of Arizona, various demographic variables (e.g., gender, college major, self-reported GPA, class standing, and number of science courses taken) were examined to determine whether they predicted science literacy. The only variable that was significant was gender, in which men performed slightly better on the science literacy assessment than women (Impey *et al.*, 2011). This science literacy assessment also was knowledge based, similar to that used in the study by Sherkat in 2011.

It is possible, however, that there may be other variables that are predictive of science literacy (pertaining more to a process of thought than a body of knowledge) and science appreciation as well. For example, instead of examining religious affiliation alone, a measure of religious commitment, i.e. religiosity, could reveal more precise information in regards to predicting science literacy and appreciation because not all those who claim religious affiliation commit to religion to the same extent. Another personality variable that may be predictive of science literacy and especially science appreciation is cynicism. It is possible that individuals high in cynicism would have a high distrust in and negative view towards authorities related to science. Political affiliation may also be predictive of science literacy and appreciation as many scientific issues, such as those stated earlier, have become highly controversial due to the perception of "left or right wing" political affiliation of the issue. In addition, another variable worth examining may be magical ideation. Magical ideation by definition is directly contradictory to science. It is belief in various aspects of causation without evidence which are illogical by common standards (Eckbald & Chapman, 1983). People high in magical ideation are more likely to have beliefs based in the paranormal, pseudoscience, and other nonscientific ways of thought (Eckbald & Chapman, 1983).

Current Study

The purpose of this study was to examine whether there are variables that are predictive of two separate criterion variables: science literacy and science appreciation. Predictor variables that were examined include those listed above: Religiosity, scriptural literalism, cynicism, political affiliation (i.e., conservative-liberalism), and magical ideation. In addition, various sociodemographic variables will be examined including self-reported gender, age, ethnicity, level of educational attainment, and parental educational attainment.

For the purposes of this study, science literacy has been operationally defined as the ability to use scientific evidence, data, and information to determine validity of scientific discourse (National Research Council, 1996), as well as the ability to use scientific information to identify problems and derive evidence based solutions (Programme for International Student Assessment, 2003). Scientific appreciation has been operationally defined as the level to which one recognizes the importance of science and the level to which one values and respects scientific research and those who hold authoritative positions in the fields of science.

It was hypothesized that there would be a significant relation between religiosity including scriptural literalism and science literacy and appreciation. It was also hypothesized there would be a significant association between cynicism and science literacy and appreciation. Additionally, it was hypothesized there would be a significant correlation between political affiliation (conservative-liberalism) and science literacy and appreciation. Finally, it was hypothesized there will be a significant correlation between magical ideation and science literacy and appreciation.

Methods

Participants

The participants in this study chose to participate through the University of Central Florida's (UCF) Psychology Research Participation System known as the Sona Systems (Sona). Data was collected throughout summer 2014 and fall 2014 semesters until October 10th. In total, 43 students participated (30 females and 13 males). All students were 18 years of age besides one 20 year old. Their self-reported ethnicities varied and included 15 White or Caucasian students, 14 Hispanic or Latino/a students, 7 Black or African American students, 5 Asian or Pacific Islander students, one American Indian or Alaskan Native student, and one Turkish student. The religious affiliations reported included 32 Christian students, 2 Agnostic and 2 Atheist students, and only one each of the following: Islam, Judaism, Buddhism, & Hinduism. Three students reported other, but did not specify. There were 15 students who reported they had a major based in natural or social sciences and 27 reported that they did not. The participants' average composite parental education was completion of vocational school or community college.

Materials

Science Literacy. The Test of Science Literacy Skills (TOSLS) was used to measure science literacy in this study, based on the definition of science literacy provided in the current study subsection. This measure is unique amongst various other science literacy measures as it is not based on factual knowledge; it is based on measurement of eight practical science literacy skills which were agreed upon by biology instructors at various universities in the U.S. (Gormally, Brickman, and Lutz, 2012). The TOSLS questions were designed to include practical evaluation skills as well as science literacy skills which are beneficial to the general public

(Gormally, *et al.*, 2012). The TOSLS is composed of 28 multiple-choice word questions. A higher amount of questions answered correctly reflects greater science literacy. Within this study, the TOSLS achieved acceptable internal reliability with a Cronbach alpha of .72.

Science Appreciation. The Science Appreciation Scale (SAS) was created to measure scientific appreciation for this study and is the first measure of its kind. The SAS is a 10-item measure and was based on the operational definition of science appreciation provided in the current study subsection. The 10 items were measured on a 5-point Likert-type scale with responses ranging from strongly disagree to strongly agree. Higher scores on the SAS indicate a greater appreciation of science. Sample items include, "It is beneficial to a nation if society understands how science works", and reverse coded items such as, "Most scientific research is a waste of taxpayers' money." Within this study, the Science Appreciation Scale achieved adequate internal reliability with a Cronbach alpha of .77. It also established convergent validity with the Test of Science Literacy Skills (r = .586, p <.001) based on the concept that those who are more literate in science are likely to be more appreciative of science.

Magical Ideation. The Magical Ideation Scale was used to measure magical ideation, that is, belief in facets of causation that are illogical and have no basis in evidence (Eckbald & Chapman, 1983). This scale contains 30 True-False items that contain claims based in magical and or irrational causation (Eckbald & Chapman, 1983). Subject content of items include superstition, astrological beliefs, paranormal beliefs, telekinetic beliefs, and content of similar sort. Within this study, this scale achieved adequate internal reliability with a Cronbach alpha of .83.

Religiosity. Participants' commitment to religion was measured using a 7-item scale created by Batson, Schroenrade, and Ventis (1993). This scale is designed to measure intrinsic religious commitment and contains statements to which participants respond using a 5-point Likert-type scale, with response options ranging from strongly disagree to strongly agree. Higher scores indicate higher levels of religiosity. Within this study, this scale achieved adequate internal reliability with a Cronbach coefficient of .88. A self-reported scriptural literalism item was also included to determine if participants believed their scripture of personal faith (e.g., Bible, Quran, etc.) to be literal, absolute truth. The item was worded as, "*My religious scripture of faith (e.g., Bible, Quran, etc.) is literally absolute truth*." The item was scored on the same 5-point Likert-type scale as the religiosity measure.

Conservative-Liberalism. To measure participants' intrinsic "right-left" political affiliation, the 7-item Conservative-Liberalism scale was used (Mehrabian, 1996). Participants select their levels of agreement with the seven items included on the scale which are measured on a 5-point Likert-type scale with response options ranging from strongly disagree to strongly agree. Higher scores reflect higher levels of liberalism and lower scores reflect greater conservative views. Within this study, this scale did not achieve acceptable internal reliability with a Cronbachs coefficient of .53.

Social Cynicism. The Social Cynicism subscale from the Social Axioms Survey (Leung & Bond, 2004) was used to assess participants' cynicism. This scale is designed to measure participants' cynicism, which is a jaded, negative attitude characterized by a distrust of the motives of others and a despondent view of the human race in general. This scale contains 18 items which are based on a 5-point Likert-type scale with response options ranging from strongly disagree to strongly agree. Within this study, this scale achieved adequate reliability with a Cronbach alpha of .87.

Procedure

This study was made available to UCF psychology undergraduates participating in Sona. Participants who log onto Sona were asked to log sociodemographic information included in the current discussion subsection. Next they were asked to complete the Test of Science Literacy Skills to avoid exhaustion effects, followed by measures for religiosity, scriptural literalism, magical ideation, cynicism, and political affiliation, and science appreciation. Participant data was then entered into SPSS and linear regressions were conducted on both criterion variables: science literacy and science appreciation.

Results

Table 1 shows the descriptive statistics of all study variables (Appendix A). Table 2 and 3 show the model summaries for both science literacy and science appreciation respectively (Appendix B). Table 4 shows the science literacy regression coefficients (Appendix B) and table 5 shows the science appreciation regression coefficients (Appendix B). To test my hypotheses, two standard multiple regressions were performed on the data. For both regressions, predictor variables were: scriptural literalism, religiosity, magical ideation, and cynicism. The two criteria were science literacy and science appreciation, respectively.

Consistent with the hypothesis, the study variables significantly predicted science literacy (Multiple R^2 =.39, F (4, 38) = 5.94, p < .001). The three predictor variables that achieved significance were scriptural literalism (B = -.725, t = -3.33, p < .01), religiosity (B = -.558, t = -2.57, p < .05), and magical ideation (B = -.494, t = -3.72, p < .01). Contrary to the hypothesis, cynicism did not contribute significantly to the prediction of science literacy.

Also consistent with the hypothesis, the study variables significantly predicted science appreciation (Multiple R^2 =.31, F (4, 38) = 4.20, p < .01). The two predictor variables that achieved significance were scriptural literalism (B = -.521, t = -2.25, p < .05), and magical ideation (B = -.422, t = -3.00, p < .01). Contrary to the hypothesis, religiosity and cynicism did not contribute significantly to the prediction of science appreciation.

Discussion

The hypotheses were that participants' levels of magical ideation, religious literalism, religiosity, social cynicism, and political affiliation would be predictive of individuals' levels of science literacy and science appreciation. For the most part, these hypotheses were supported. Individuals' levels of magical ideation, religious literalism, and religiosity were all strongly related to lower levels of science literacy. The hypothesis that cynicism was related to science literacy was not supported, and whether political affiliation was related to science literacy (or science appreciation) was inconclusive because the measure used to gauge left-right political affiliation was unreliable. The hypothesis that higher degrees of magical ideation and religious literalism would be related to science appreciation also was supported; individuals with higher levels of magical ideation and religious literalism had much lower levels of appreciation for science. Higher degrees of religiosity also were related to lower levels of appreciation for science, but only to a moderate extent. Cynicism was unrelated to appreciation of science.

The average science literacy score of participants was less than average, with the average score being approximately equivalent to scoring a 41% on a test. In addition, it also was discovered that participants' average science appreciation was lower than expected as well. University students scoring so low on science literacy and science appreciation assessments holds grave implications in regards to the science literacy and appreciation of the general public. Specifically, these results are consistent with findings that the science literacy of the United States is much lower than it should be (Baldi et al., 2008; Bybee, 2008; Bybee, McCrae, & Laurie, 2009; Cromley, 2009, Impey *et al*., 2011).

The poor science appreciation displayed by the U.S. government—through abolishment of scientific offices of congress such as the Office of Technological Assessment and miniscule funding of scientific research—also was reflected by participants. If university students have low levels of science literacy and science appreciation, it is quite probable that the general public is even less literate in and appreciative of science. As stated in the introduction, there are foreseeable dangers in the future of a nation that is unappreciative of and illiterate in science that also is highly reliant on science and technology. Some of the most critical and controversial issues of our time in relation to global climate change, sustainability, modern medicine, educational curricula, and more, are addressable appropriately only with science, and the policy makers of our country appear to have meager and diminishing expertise in the field (Manning, 2012; Sadowski, 2012). This places a great responsibility upon the U.S. populace to maintain literacy in, or at minimal appreciation of science so that we may make logical, informed decisions.

In regards to variables predictive of science literacy and appreciation, the strongest predictor variable was magical ideation, or magical thought. This finding supports the view that those who engage in magical thinking, characterized by beliefs without ground in neither logic nor basis in evidence (e.g., belief in astrology), are blatantly defying the evidence-based reasoning that is integral to scientific methodology and science literacy in general. Individuals who engage in magical thought believe in facets of causation that often are illogical and have no basis in evidence (Eckbald & Chapman, 1983). They may be more prone to making important decisions on real-life issues (such as vaccinations or the genetic modification of foods) without any evidential basis. They also likely are unfamiliar with the methodology used in sciences to distinguish fact from speculation, misinformation, or fiction. Such facets of magical ideation such as belief in superstition and pseudosciences (e.g., astrology and homeopathy) that are propagated in popular culture should include a disclaimer that the information presented has neither evidential nor scientific support.

The remaining variables that were predictive of science literacy and science appreciation are possibly the most relevant to our society, and they are both related to religion: scriptural literalism and religiosity (the latter was only strongly predictive of science literacy, and only moderately predictive of science appreciation). This finding supports research conducted by Sherkat in 2012 which found that religiosity was negatively related with science literacy. Among the participants in this current study, approximately 75% reported Christianity as their religion, which is reflective of 77% of the U.S. population reported in a Gallup Poll (Newport, 2012). The likely reason that scriptural literalists, individuals who believe their scripture of faith to be literal and factual truth, and highly religious individuals were less likely to be literate in science seems clear. Religion in general is based on belief without evidence. It is likely that highly religious individuals also are less appreciative of science because much information presented by science directly conflicts with religion, such as the age of the earth, how it was created, et cetera. It is likely that these individuals were indoctrinated as a child to resist scientific reasoning and maintain beliefs without any supporting evidence. The two concepts (religion and science) are overall contradictory in nature. Religion claims absolute knowledge without reasoning, and science seeks knowledge with logical and/or evidential reasoning. To maintain both, one must arguably manage a high level of cognitive dissonance.

Not only is religion widespread in the U.S. (or at least is self-reported as so), it is even more prevalent in our government as reported by Pew Research Center in 2013, with an staggering 87.1% of government officials reporting affiliation with Christianity, and less than 1%

of congress report no religion. Despite that science literacy is beneficial to the decisions made by a nation (Bybee, 2008; Bloch, 1986; Cromley, 2009; Drori, 2003; Eisenhart, Finkel, & Marion 1996; Laugksch, 2000; Lewis, 1982; Miller, 1998; Rutherford & Ahlgren, 1991; Walberg, 1983), our policy makers in the U.S. report overwhelmingly to be religious. This reinforces the necessity for a reimplementation of a nonpartisan Office of Congress such as the OTA, composed of experts who are highly literate in science to assist in decision-making on scientific issues. In regards to the general public, this reinforces the need to petition for and vote to appropriate greater funds to scientific institutions, encourage science literacy, and encourage science appreciation.

It has been discovered that that the benefits of a nation literate in science are great (Bybee, 2008; Bloch, 1986; Cromley, 2009; Drori, 2003; Eisenhart, Finkel, & Marion 1996; Laugksch, 2000; Lewis, 1982; Miller, 1998; Rutherford & Ahlgren, 1991; Walberg, 1983). In addition, there exists a consensus that the real-world implications of science literacy are of significant importance (Bodmer, 1985; Bybee, 1993; Deboer, 2000; Maienschein, 1998; Millar, Nott, & Osborne, 1998; Rutherford & Ahlgren, 1990). Therefore it should be of high priority for our nation to improve the science literacy and appreciation of our population and in our government. To begin with, to reopen the Office of Technological Assessment, or another nonpartisan office of congress of similar sorts which consisted of nonpartisan members with expertise in scientific fields of education, would be advantageous. It also is recommended that the government appropriates greater funding to scientific institutions than the diminutive amount it currently does, and make strides to improve the public understanding and appreciation of science. This could be done through various social programs, and especially a more affordable and effective education system, which evidence suggests is failing us as there has been no noticeable improvement in science literacy of college students in the past twenty years (Impey *et al.*, 2011).

It also is highly recommended that we engender greater civic appreciation of science. If there exists various holidays and appreciation months for various ethnicities, disabilities, sexual orientations, genres of music, poetry, and more, then it seems only appropriate to dedicate a month to science as well. Furthermore, it is common-place for other countries to place famous scientists and representations of their findings on their currency (Feller, 2010). This is uncommon in the U.S., but it would be a great way to encourage appreciation of science as individuals on currency are frequently seen and commonly recognized as important. It also would be highly beneficial for the entertainment industry to tap into programs that provide education in science while bolstering appreciation of science like programs such as *Cosmos: A SpaceTime Odyssey.* Further, the major media must be encouraged to present scientifically accurate information, and it must stop lending equal credibility to both sides of a scientific predicament when one side has been disproven, such as whether or not global climate change exists when a vast majority of climate scientists agree that it does, and that it has anthropogenic influences (Cook *et al.*, 2013). It is also important to for the media to distinguish between a scientific theory, which is based on volumes of evidence (such as the Darwinian Theory of Evolution), and common use of the word theory which is more similar to that of an untested scientific hypothesis (such as the Creationist “Theory” of Evolution). Overall, this lack of civic science literacy and appreciation is a predicament of great importance that must be confronted.

In conclusion, it was found that the variables predictive of lower levels of science literacy and appreciation—magical ideation, scriptural literalism, and religiosity—are all related to thought paradigms that directly refute the logical, evidential reasoning prevalent in science literacy. Change must be made for scientific problems to be addressed appropriately, whether it be by literacy in science or at least appreciation of science. It is suggested that the government recreate another nonpartisan, scientific Office of Congress to improve policy making of our nation. It also is recommended for the government and media outlets in the U.S. to encourage literacy in science and appreciation of science. However, what may be of utmost importance, is the improvement of educational programs in the U.S. to place greater value and emphasis on teaching students how science works, why it works, and why we should appreciate it.

Limitations and Future Research

The greatest limitation of this study was the participants sampled. Specifically, the sample was restricted to undergraduate college students, and only 43 individuals chose to participate. I recommend that future researchers collect a larger sample more representative of the general population. In addition, very little research has been conducted on predictors of science literacy, and even less on the appreciation of science. I suggest researching the relationship between political affiliation (and affiliation with various other social groups) and science literacy and appreciation. I also recommend more research be conducted on what may predict these two variables in countries outside the U.S. because the benefits of populaces literate in and appreciative of science warrant promotion of science across cultures.

Appendix A

Table 1:
Descriptive Statistics

	N	Range	Minimum	Maximum	Mean	Std. Deviation	Variance
Scriptural Literalism Item	43	4.00	1.00	5.00	2.9070	1.15086	1.324
Religiosity Average	43	3.78	1.22	5.00	3.0563	.84547	.715
Social Cynicism Average	43	2.06	1.94	4.00	2.9937	.51822	.269
Total Magical Ideation	43	24.00	1.00	25.00	10.6977	5.76333	33.216
Total Number Correct on Test of Science Literacy Skills	43	22.00	3.00	25.00	11.3953	4.62467	21.388
Science Appreciation Average	43	1.80	2.90	4.70	3.5465	.48958	.240
Valid N (listwise)	43						

Appendix B

Table 2: Science Literacy
Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.620[a]	.385	.320	3.81327	.385	5.944	4	38	.001

a. Predictors: (Constant), Total Magical Ideation, Scriptural Literalism Item, Social Cynicism Average, Religiosity Average

Table 3: Science Appreciation
Model Summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics				
					R Square Change	F Change	df1	df2	Sig. F Change
1	.553[a]	.306	.233	.42868	.306	4.196	4	38	.007

a. Predictors: (Constant), Total Magical Ideation, Scriptural Literalism Item, Social Cynicism Average, Religiosity Average

Table 4 Science Literacy
Coefficients[a]

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations		
	B	Std. Error	Beta			Zero-order	Partial	Part
(Constant)	12.845	3.962		3.242	.002			
Scriptural Literalism Item	-2.912	.876	-.725	-3.326	.002	-.315	-.475	-.423
Religiosity Average	-3.050	1.188	-.558	-2.568	.014	-.106	-.385	-.327
Social Cynicism Average	.645	1.190	.072	.542	.591	-.111	.088	.069
Total Magical Ideation	-.396	.106	-.494	-3.724	.001	-.453	-.517	-.474

a. Dependent Variable: Total Number Correct on Test of Science Literacy Skills

Table 5 Science Appreciation

Coefficients[a]

Model	Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Correlations		
	B	Std. Error	Beta			Zero-order	Partial	Part
(Constant)	4.086	.445		9.172	.000			
Scriptural Literalism Item	-.221	.098	-.521	-2.250	.030	-.364	-.343	-.304
Religiosity Average	.143	.134	-.247	-1.070	.292	-.247	-.171	-.145
Social Cynicism Average	.017	.134	.018	.128	.899	-.147	.021	.017
Total Magical Ideation	-.036	.012	-.422	-2.995	.005	-.428	-.437	-.405

a. Dependent Variable: Science Appreciation Average

References

Baldi, S., Jin, Y., Skemer, M., Green, P. J., Herget, D., and Xie, H. (2008). Performance of U.S. 15 year old students in science and mathematics literacy in an international context. Washington, DC: National Center for Education Statistics.

Batson, C. D., Schoenrade, P., & Ventis, W. L. (1993). Religion and the individual: A social psychological perspective. Oxford University Press.

Bloch, E. (1986). Basic research and economic health: The coming challenge. *Science, 232*(4750), 595-599.

Bodmer, W. F. (1986). *The public understanding of science*. Royal Society.

Braten, I., Stromso, H. I., & Salmeron, L. (2011). Trust and mistrust when students read multiple information sources about climate change. *Learning and Instruction*, *21*(2), 180-192.

Brem, S.K., Russell, J., & Weems, L. (2011). Science on the web: student evaluations of scientific arguments. *Discourse Process 32*, 191–213.

Britt, M. A., & Aglinskas, C. (2002). Improving students' ability to identify and use source information. *Cognition and instruction*, *20*(4), 485-522.

Bybee, R. W. (1993). *Reforming Science Education. Social Perspectives & Personal Reflections*. Teachers College Press, 1234 Amsterdam Avenue, New York, NY 10027 (Hardcover: ISBN-0-8077-3261-3; paperback: ISBN-0-8077-3260-5).

Bybee, R. W. (2008). Scientific literacy, environmental issues, and PISA 2006: The 2008 Paul F-Brandwein lecture. *Journal of Science Education and Technology, 17*(6), 566-585.

Bybee, R. W., McCrae, B., & Laurie, R. (2009). PISA 2006: An assessment of scientific literacy. *Journal of Research in Science Teaching*, *46*(8), 865-883.

Cook, W.D. (1977). Adult Literacy Education in the United States. Newark, DE: International Reading Association.

Cook, J., Nuccitelli, D., Skuce, A., Jacobs, P., Painting, R., Honeycutt, R., & ... Way, R. G. (2014). Reply to 'Quantifying the consensus on anthropogenic global warming in the scientific literature: A re-analysis'. Energy Policy, 73706-708.

Cromley, J. G. (2009). Reading achievement and science proficiency: International comparisons from the Programme on International Student Assessment. *Reading Psychology*, *30*(2), 89-118.

DeBoer, G. E. (2000). Scientific literacy: Another look at its historical and contemporary meanings and its relationship to science education reform. *Journal of Research in Science Teaching*, *37*(6), 582-601.

Drori, G. S. (Ed.). (2003). *Science in the modern world polity: Institutionalization and globalization*. Stanford University Press. Stanford, CA: Stanford University Press.

Eckblad, M., & Chapman, L. J. (1983). Magical ideation as an indicator of schizotypy. *Journal of consulting and clinical psychology*, *51*(2), 215.

Eisenhart, M., Finkel, E., & Marion, S. F. (1996). Creating the conditions for scientific literacy: A re-examination. *American Educational Research Journal*, *33*(2), 261-295.

Feller, S. A. (2010). 20th Century Physicists On Bank Notes.

Fox, S. (2006). *Online health search 2006*. Pew Internet & American Life Project.

Gormally, C., Brickman, P., & Lutz, M. (2012). Developing a Test of Scientific Literacy Skills (TOSLS): Measuring Undergraduates' Evaluation of Scientific Information and Arguments. *CBE-Life Sciences Education*, *11*(4), 364-377.

Impey, C., Buxner, S., Antonellis, J., Johnson, E., & King, C. (2011). A twenty-year survey of science literacy among college undergraduates. *J. Coll. Sci. Teach*, *40*, 31-37.

Koballa, T., Kemp, A., & Evans, R. (1997). The Spectrum of Scientific Literacy. *Science Teacher*, *64*(7), 27-31.

Kuiper, E., Volman, M., & Terwel, J. (2005). The Web as an information resource in K–12 education: Strategies for supporting students in searching and processing information. *Review of Educational Research*, *75*(3), 285-328.

Kutner, M., Greenberg, E., Jin, Y., Boyle, B., Hsu, Y. C., & Dunleavy, E. (2007). Literacy in Everyday Life: Results from the 2003 National Assessment of Adult Literacy. NCES 2007-490. *National Center for Education Statistics*.

Laugksch, R. C. (2000). Scientific literacy: A conceptual overview. *Science education*, *84*(1), 71-94.

Leung, K., & Bond, M. H. (2004). Social axioms: A model for social beliefs in multicultural perspective. *Advances in experimental social psychology*, *36*, 119-197.

Lewis, J. D. (1982). Technology, enterprise, and American economic growth. *Science*, *215*(4537), 1204-1211.

Maienschein, J. (1998). Scientific literacy. *Science*, *281*, 917.

Mehrabian, A. (1996). Relations among political attitudes, personality, and psychopathology assessed with new measures of libertarianism and conservatism. Basic and Applied Social Psychology, 18, 469–491.

Millar R., Osborne J., Nott M. (1998). Science education for the future. *School of Science Revision 80*, 19–24.

Miller, J. D. (1983). Scientific literacy: A conceptual and empirical review. *Daedalus*, *112*(2), 29-48.

Miller, J. D. (1998). The measurement of civic scientific literacy. *Public Understanding of Science*, *7*(3), 203-223.

National Science Board. (2012). Science and engineering indicators. Washington DC: National Science Foundation

National Research Council (Ed.). (1996). *National science education standards*. National Academy Press.

Programme for International Student Assessment. (2003). *PISA The PISA 2003 Assessment Framework: Mathematics, Reading, Science and Problem Solving Knowledge and Skills*. OECD Publishing.

Rutherford, F. J., & Ahlgren, A. (1991). *Science for all Americans*. Oxford university press.

Ryder J (2001). Identifying science understanding for functional scientific literacy. *Study of Scientific Education 36*, 1–44.

Sadowski, J. (2012). *The Much-Needed and Sane Congressional Office That Gingrich Killed Off and We Need Back.* Retrieved from:

http://www.theatlantic.com/technology/archive/2012/10/the-much-needed-and-sane-congressional-office-that-gingrich-killed-off-and-we-need-back/264160/

Sargent, J. F. (2014). *Federal Research and Development Funding: Fy 2015*. DIANE Publishing.

Sherkat, D. E. (2011). Religion and scientific literacy in the United States. *Social Science Quarterly*, *92*(5), 1134-1150.

Smith, Aaron. "Older adults and technology use." Washington: Pew Research Center (2014).

Uno, G. E., & Bybee, R. W. (1994). Understanding the dimensions of biological literacy. *BioScience*, *44*(8), 553-557.

Walberg, H. J. (1983). Scientific literacy and economic productivity in international perspective. *Daedalus*, *112*(2), 1-28.

Walraven, A., Brand-Gruwel, S., & Boshuizen, H. (2009). How students evaluate information and sources when searching the World Wide Web for information. *Computers & Education*, *52*(1), 234-246.

Woodin, T., Carter, V. C., & Fletcher, L. (2010). Vision and change in biology undergraduate education, a call for action—initial responses. *CBE-Life Sciences Education*, *9*(2), 71-73.