Public Perception of Socio-Scientific Issues Do You Decide Based on Your Education, Your Experience or Reading the News?

Burcu Demiralp
Claremont Graduate University

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Approval of the Dissertation Committee

This dissertation has been duly read, reviewed, and critiqued by the Committee listed below, which hereby approves the manuscript of Burcu Demiralp as fulfilling the scope and quality requirements for meriting the degree of Doctor of Philosophy in Education.

David Drew, Chair
Claremont Graduate University
Professor of Education

June Hilton
Claremont Graduate University
Professor of Education

DeLacy Ganley
Claremont Graduate University
Professor of Education

Abstract

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One of the challenges humans face is making collective decisions with regards to controversial issues related to science, namely socio-scientific issues (SSIs). Genetic modification, nuclear energy, experimental drugs, 5G technology are a few examples of SSIs. Some of the concerns posed by such issues are compromise to privacy and identity, threat to the workforce due to automation, and potential changes to the human genome. To better understand SSI-related decision making, it is important to understand the public perception of SSIs, while also including opinions of rural areas.

This research investigated the perception of SSIs for the U.S. public both in a small U.S. rural area, and in the whole country. Study 1 (N=162) focused on a rural area and was conducted through an online survey posted to social media, while Study 2 (N=2002) used a national sample as part of a secondary data analysis from the Pew Research Center. Both studies looked at the relationship between levels of general education, science knowledge, and perception of SSI-related innovations.

One of the main findings from Study 1 (which relied on correlation analysis) is that higher levels of education relate to increased support for use of animals for research and increased agreement on the safety of GMO foods. However, Study 2 (which used binary logistic

regression analysis) found that as education level increased, the odds of supporting fracking or agreeing that GMO food is safe decreased. Study 1, also showed that as science knowledge increased support for fracking decreased, while agreement on the safety of GMO food increased. Study2, on the other hand indicated that the odds of support for SSIs decreased for use of plant fuel, animals for research, experimental drugs, and artificial organs.

Additionally Study 1 looked at holding a science degree and Study 2 looked at keeping up with science news as potential variables related to perceptions of SSIs. T test analysis in Study 1 showed that science degree holders favored virus modification, nuclear energy, use of animals for research and viewed GMO foods as safe, while non-science degree holders did not. In Study 2, as familiarity with science news increased support for offshore oil and gas drilling switched from support to opposition, while view of modification of baby genes for smarter babies switched from taking science too far to appropriate. Lastly, multiple regression analysis in Study 1 showed that mean perception of health-related innovations is a significant predictor of use of the Covid-19 vaccine even though its clinical trials have not been completed.

To conclude, an interesting overall finding was that rural area participants indicated more opposition to SSIs than the national sample. And, science news and holding a science degree seemed to behave differently than education level and science knowledge with a leaning towards more support of SSIs. These findings may help shape policies and practices related to media in how science news are produced and shared, increase our awareness of opinions of rural areas, and broaden our conception of science to include human experience and its connection to nature.

Keywords: Socio-scientific issues, education level, science knowledge, science education, science news

"*Science is the belief in the ignorance of experts.*"

Richard Feynman

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Chapter 1: Public Perception of Socio-scientific issues

Introduction: Socio-scientific issues

Socio-scientific issues (SSIs) are issues related to science that are controversial in terms of public perception (Zeidler & Keefer, 2003). Any study of SSIs requires a holistic understanding of the open-ended problems by means of using science, ethics, economics and morality in order to wisely choose amongst the various possible solutions. Some examples of SSIs are the genetic modification of foods, animals, or fetuses, climate change, animal testing for medical research, oil drilling in national parks, new mRNA vaccines such as used for the Covid-19 pandemic, etc.

The social advancements brought in by the scientific and technological developments of the last few decades are obvious and diverse, ranging from an increased human survival rate through vaccination (e.g., Levinson, 2006), to easier access to energy and food (e.g.,Walker, 2003; Wu & Tsai, 2010), to the enhanced means of communication through mobile phones. However, research also indicates an increasing public concern regarding potential risks to public health and the environment in relation to these scientific and technological developments (Christensen, 2007; Fortner et al., 2000). These concerns include the health effects of genetically modified food and wireless technology, possible threats to the survival of humanity caused by climate change, threats to privacy and identity, threats to the workforce due to automation, and threats to the human genome.

So that human understanding and public perception can progress in tandem with scientific process, and in order to avoid politics interfering with scientific inquiry, it is important to be aware of our individual and collective perception of SSIs. SSI-related decisions affect citizens directly or indirectly. For example, when we consider public perception of the topic of climate change, our daily behavior and political choices of, say, our carbon footprint, all add up creating an overall effect on the state of Earth's atmosphere and survival of humanity. Therefore, it is crucial for us as researchers to understand how citizens perceive, understand, and anticipate the outcomes of SSIs, and then for us to find the factors that influence public perception of SSIs and related developments. Further, it would be good to look at rural areas and make sure their opinions and views related to SSIs are also acknowledged.

Background

It is important to first understand what counts as a SSI, to realize its controversial nature, and be aware f the causes of the controversy. Public perception, naturally, leads to preconceptions, and ultimately political outcomes that may hinder further scientific inquiry or even the ability to carry out good science. In order to understand collective attitudes towards SSIs, it is important to distinguish potential factors that may influence the perception of SSIs, such as how much people know about science and the scientific method in general. This research will investigate the general public's science knowledge levels, general education and science education levels, and frequency of exposure to science news as potential factors that may influence perception of SSIs. Knowing more about the role of these factors will help us understand the manifestation of collective public perception towards SSIs. With that, the following sections will explore more in detail what counts as an SSI, its controversial nature, and allude to potential factors that may influence perception of SSIs.

A More Detailed Definition of SSIs

SSIs are problems involving the public understanding and application of contemporary developments in science; these misunderstandings can be conceptual, procedural, or technological (Sadler & Zeidler, 2005). The themes of socio-scientific problems can be vast, but are often related to the environment, public health or genetics. Some examples of SSIs that are conceptual are evolution, climate change, The Big Bang, and invasive species. Other examples that are more technological or procedural are fracking, stem cell, nuclear energy, reproductive genetic modification, vaccination, GMO food use, and wireless technology. SSIs do not have clear-cut solutions (e.g., Crick, 1998; Kolsto, 2001; Levinson, 2006; Sadler, 2004; Topcu, 2010), with some social groups disagreeing either with SSIs' proposed solutions, or even with their very existence.

The Controversial Nature of SSIs

There are four criteria for an issue to be accepted as controversial: (1) the existence of conflicting key beliefs, understandings, values, or knowledge claims held by groups or individuals, where solutions involve the rational analysis of underlying premises of different groups (Crick, 1998; Kolstø, 2001a; Levinson, 2006); (2) the existence of a significant number of people or groups that hold different views (Crick, 1998; Levinson, 2006); (3) insufficient evidence for a straightforward solution (Sadler, 2004; Topcu, 2010); and (4) an apparent lack of consensus within the scientific community about the issue (Kolsto, 2001a, 2006). According to Borgerding and Dagistan (2018), the controversy regarding an SSI is situated within a local context, and mainly has to do with the safety or justice of the scientific procedure, the general knowledge of it, or the technology involved. Other researchers (Hansen & Hamman, 2017) have taken the question of safety further and presented it as risk perception related to the related SSI questions. Science controversies have been further differentiated into three categories: Society-denied, society-accepted and active-science (Borgerding & Dagistan, 2018). ***Society-denied controversies*** involve widespread consensus in the scientific community but are rejected by segments within society, e.g., the wide acceptance of climate change, but the denial of anthropogenic causes of climate change by some groups. ***Society-accepted controversies***, on the other hand, include approved scientific developments that are accepted as a scientific development, but raise further questions from the public regarding the safety of the applications of scientific developments, e.g., the question of reproductive genetic modification. Scientists are actively using genetic modification for plants and animals, but as far as the public is concerned the safety of these modifications is not clear. Finally, ***active-science controversies*** are essentially "science in the making," with active debate amongst the scientific experts regarding the content and interpretation of the involved science; e.g., wireless technology and the possible unhealthy consequences of its widespread use.

SSIs are controversial due to the inherently diverse perspectives—ethical, moral, political, social and economic—that go into the very definition of SSIs. The multidisciplinary nature of SSI problems has been described by the SEE-SEP model (Chang, Rundgren & Rundgren, 2010), which stands for (S) sociology/culture, (E) environment, (E) economy, (S) science, (E) ethics and morality and (P) policy. Debates necessarily involve scientific experts, politicians, and citizens—a group so diverse that reaching a consensus is difficult. Therefore, it is important for researchers to anticipate the standpoint of not only trained scientists, but also non-scientists in order to be make the most-informed holistic decisions together. More research investigating the relationship between each group, namely politicians, scientists and citizens, with regards to SSIs is needed.

Potential Factors Affecting Public Perception of SSIs

A 2015 global research conducted by Yale University, Columbia University, Utah State University, Princeton University, The University of Massachusetts-Amherst, and Academia

Sinica in Taipei used Gallup data to look at 119 countries with regards to their perception of climate change (Lee et al., 2015). They found that 40 percent of adults worldwide are not familiar with the concept of climate change, at least in terms of a clear scientific definition. Further, their research indicated that developing countries showed significantly more unawareness of the existence of climate change, with 65 percent of the population being unfamiliar with the concept. Their conclusion was that globally the strongest factor related to unawareness of climate change was education. Based on this finding, one may consider the relationship between general education, particularly science education, and public perception of all SSIs.

There has been ample research in the last decade about high-school and college students at various ages, and students' processing of SSIs. Results indicated a positive relationship between scientific literacy and quality of student argumentation with regards to SSIs (Cavagetto, 2010). However, there has also been research pointing to low scientific literacy in the public (e.g., Miller, 2010), with only about a quarter of people in the United States being able to comprehend the science section of The New York Times.

"Scientific literacy" in these studies is conceptualized generally as the level of understanding of science and technology needed to function as a citizen in modern industrial society. For example, Miller (2010) has explored U.S. civic scientific literacy by asking open-ended questions about stem cells, neurons, neuroscience, and nanotechnology as well as closed-ended questions about genetic modification of plants and animals, ecology, infectious diseases and nanotechnology. By these measures, to be classified as "scientifically literate," one needed to understand basic concepts and constructs such as the molecule, DNA, and the structure of the solar system. Additionally, respondents needed to understand the nature and process of scientific inquiry and to display a regular consumption of information (Miller, 1998). Results showed that only about 17 percent of Americans were "scientifically literate" in 1999; even though this rate was higher than Canada, the European Union and Japan (Miller et al., 1997), it was still too low to keep up with the accelerating scientific and technological developments of current times.

Thus there is a need for research that identifies public perception of SSIs. So far, socio-scientific researchers have focused on four broad themes: a) SSIs as engagement of curriculum practice and teachers' pedagogical beliefs, b) SSIs as epistemological development and reasoning, c) SSIs as a context for Nature of Science (NOS), and d) SSIs as character development and citizenship responsibility in order to understand and change SSI perceptions.

However, researcher surveys have focused mainly on students (Zeidler, 2014). While it is important to understand and increase students' awareness of SSIs, this dissertation argues that it is even more important to understand the general public's perception and behavior of SSIs, as it has more political power than students in affecting the trajectory of SSIs, due to their day-to-day activities and decisions as consumers, and of course indirectly through their political affiliations. Research has shown that public perception and attitudes towards Covid-19 continue to affect the course of the pandemic. Moreover, according to the U.S. Census Bureau (2018), indicated that about 80 percent of the population is over the age of 18 years old, so only surveying students misses the majority of the public. This dissertation will attempt to fill that research gap.

After broadening the research focus, preliminary findings are disconcerting. SSI research has indicated that the general public has a lack of understanding of what counts as evidence, which affects the ability to informed decisions grounded in empirical evidence (Collins et al., 2007; Covitt et al., 2009; McBeth & Volk 2009; Miller, 2004). Consequently, the current study argues for a shift of focus from the students to the adult public, defined as U.S. citizens and legal residents aged 18 years and above. It is particularly focused on understanding the relationship between U.S. citizens and residents and their perception of SSIs. The next section will explain this in more detail.

Purpose of This Study

This research reviews the current state of research on SSIs, with a focus on the relationship between scientific literacy, science education level, general education level, interest in science news, and the public's perception of SSI-related innovations. Further, as part of it, this research includes perceptions of residents from a highly educated small rural area known for its respect and connection to nature while being surrounded by 6 million acres of Adirondack State Park. Using data collected from a rural area in Upstate NY (Study 1), and also a secondary analysis of 2014 Pew research data (Study 2), the current study investigates the relationships between the perception of SSI-related innovations, the level of scientific knowledge, the level of education, the level of science education, and the level of interest in keeping up with science news. In addition, Study 1 investigates particularly Covid-19 as a current SSI. The research questions follow.

Research Questions

Study 1

Research Question 1: What is the relationship between the level of scientific knowledge and the perception of SSI-related innovations in the areas of energy, health and space?

Research Question 2: What is the relationship between the level of education and the perception of SSI-related innovations in the areas of energy, health and space?

Research Question 3: What is the relationship between having a science degree or not, and the perception of SSI-related innovations in the areas of energy, health and space?

Research Question 4: What are the predictors of using a new Covid-19 vaccine even though all clinical trials have not been completed?

Study 2

Research Question 1:

Does a person's keeping up with science news, education level and science knowledge predict that person's perception of socio-scientific innovations in the areas of energy (fracking, nuclear, genetic plants and offshore oil and gas drilling), and health (animal use for research, use of experimental drugs, genetic modification of artificial organs, baby genetic modification to make them more intelligent, safety of pesticides, and safety of genetically modified food)?

Significance of This Study

This study highlights selected variables influencing the perception of SSI-related innovations. It looks at how a person's levels of science knowledge, science education, and general education are related to their perception of SSI-related innovations, within a small rural area, also a focus on the perception of current SSI, Covid-19. This small rural area in the Adirondack State Park region of NY is unique in the sense of being highly educated and being actively involved in nature related activities. Indeed it is a spot for nature tourism with its plenty of opportunities for hiking, rock climbing, ice climbing, XC skiing, downhill skiing, canoeing, ice skating etc. In addition, this study also looks at how a person's frequency of keeping up with science news, and their general education and science knowledge levels are related to perception of SSI-related innovations in the U.S. nationwide.

Overall, this study will contribute significantly to the existing literature. To the writer's knowledge, this is the first study investigating U.S. adult perceptions of SSI-related innovations in a U.S. rural area, with a particular focus on the level of scientific knowledge, the level of science education, and the level of general education. Secondly, this is the only study looking at adults' perception of the current SSI of Covid-19 in a small rural area at a time when the concept of the Covid-19 epidemic was newly emerging. Lastly, the current study is unique in the sense that it enables comparison between a small adult sample from a rural area, and a larger more diverse adult sample from all over the U.S., including rural, suburban and urban areas with respect to the relationship between scientific knowledge level, and general education level. Results will inform us of the U.S. general public's perception of SSI-related innovations as influenced by levels of scientific knowledge, general education, science education, and frequency of keeping up with science news, including a comparative rural perspective. Further, it will enlighten the impact of rural area in these decisions. Lastly, it will add to the research about public perceptions of Covid-19.

These results, by presenting a deeper understanding of how public perceptions of SSI-related innovations are formed, have the potential to enable researchers, policy makers, and educators to make the necessary adjustments in their curricula, programs, policies and communication, enabling the general public to have a better understanding of SSIs and play a conscious role through their behaviors and choices. The results may, for example, guide educators to an improved way of teaching science, or a new way of general teaching that leads to more rigorous critical thinking. Understanding perception of how SSIs are perceived may also open up a path to a new era of communication amongst news sources, policy makers, teachers, and the general public that is more conscious of the interconnected nature of all phenomena, where conditions are created for the public to practice critical thinking, rightful open communication, and wise holistic decision-making.

Chapter 2: Review of the Literature

Existing SSI research has focused on the concept of SSIs; the implementation of socio-scientific courses or pedagogies in schools, colleges, universities, graduate programs, teacher training programs; the evaluation of these courses and trainings with regards to changes in students' argumentation and reasoning skills related to SSIs; and teacher perceptions of SSIs as a teaching tool (e.g., Albe, 2008; Barrue & Albe, 2013; Bryce & Gray, 2004; Concannon et al. 2010; Fowler & Zeidler, 2016; Sadler, 2004; Simmoneux, 2007; Simmoneux & Simmoneux, 2009; Zeidler & Nichols, 2009). The frequently researched variables in SSI research have been the nature of science (e.g., Sadler, 2004; Sadler & Zeidler, 2005) and the epistemological beliefs and informal reasoning in relation to SSIs (Sadler, 2004). However, SSI studies (e.g., Albe, 2008; Barrue & Albe, 2013; Bryce & Gray, 2004; Concannon et al., 2010; Fowler & Zeidler, 2016; Sadler, 2004; Simmoneux, 2007; Simmoneux & Simmoneux, 2009; Zeidler & Nichols, 2009) have generally focused on samples of students from preschool to graduate level. To emphasize and elucidate public perceptions of SSIs, the current study will look at a sample population in rural Upstate NY, as well as the U.S. public in general, and examine select variables in relation to public decision-making with regards to SSI.

As one variable that potentially influences SSI perceptions, Lewis and Leach (2006) put forth the concept of "scientific literacy," which is knowledge about scientific content and process. Lederman and Lederman (2014) argue that to make informed decisions about SSIs, one must understand the content as well as the process by which the content was developed. In line with these findings, the following sections will look at scientific literacy, general education level, and science education level in more depth. I will start with scientific literacy with a particular focus on keeping up with science news.

Scientific Literacy

There seems to be little agreement on the definition of "scientific literacy," even though it has been an explicit goal within science education (American Association for the Advancement of Science [AAAS], 1989; Halyard, 1993; National Research Council [NRC], 1996a, 1996b, 1999; National Science Foundation [NSF], 1998). Science literacy has been often seen as scientific content knowledge and understanding, and there is ample research on students indicating the importance of scientific content knowledge in making higher quality decisions regarding SSIs (Birmingham & Barton, 2014; Rudsberg & Ohman, 2015; Sadler & Fowler, 2006a). Students are more likely to refer to related scientific knowledge such as research findings, as opposed to personal opinions when making arguments about relevant issues (Rose & Barton, 2012; Sadler & Fowler 2006a). Tsai (2013) has found that middle school students also refer to their scientific knowledge, but only when prompted in making arguments about relevant issues. However, it can also be challenging for students to incorporate knowledge into their arguments depending on their age and their development (Jin et al., 2015). Second-year college students identified scientific evidence as most convincing with regards to SSI-related questions (Brem & Rips, 2000). On the other hand, most of the high-school students chose the SSI argument that is closest to their original belief as the most convincing (Sadler, Chambers & Zeidler, 2004). These findings highlight the importance of the natural developmental stages with respect to decision-making. As the aforementioned studies indicate, the factors that affect decision making with regards to SSIs seem to include elements of belief about the subject, and knowledge of facts related to the issue. However, both of these elements are influenced by developmental stages. Adulthood itself is another developmental stage, and it would be interesting to look at how elements of belief and scientific knowledge of facts play into perception of SSIs.

Moving beyond the vision of scientific literacy as scientific content knowledge, researchers (e.g.,Gautier, 2012; Corbett & Durfee, 2004) emphasize the procedural understanding of science, the process of scientific method, and scientific research and scientific reasoning—and include it in their definitions of scientific literacy. Gautier (2012) suggested that understanding the peer review process of publications would enable students and citizens to understand the science behind a scientific argument as it goes through critical evaluation, which would help students and citizens distinguish between a rhetorical claim with no real evidence and an evidence-based claim. In addition, understanding the peer-review process would decrease the perception of an argument as controversial and could lead to more agreement. Plenty of research has shown that when a scientific issue is perceived as more controversial by the public, this generates skepticism and results in a general sense of doubt in the public (Corbett & Durfee, 2004; Dixon & Clarke, 2013b; Dixon et al., 2015; Kortenkamp & Basten, 2015). Additional research (Dixon & Clarke, 2013a; Nagler, 2014) has indicated that perception of an issue as controversial leads to less action that supports the socio scientific issue related innovation, So, in order to work with the controversial nature of SSIs in the most constructive, productive way, it is important to have a clear procedural understanding of the science as well. That is one of the main goals of science education—the procedural understanding of science—so it would be interesting to investigate the relationship between the level of science education and the perception of SSIs.

However, this relatively broadened view of scientific literacy focusing on the scientific method, i.e., scientific thinking as well as scientific content, is still not holistic enough, and neglects the interdisciplinary relationships between science and other disciplines such as humanities, politics, and economics. Recent research (Ingo et al., 2013) has indicated the need for a third and relatively more contemporary view of scientific literacy that considers the multidimensional nature of SSIs. This new contemporary view of scientific literacy would hold a more societal position with regards to scientific literacy, and enable citizens to actively participate in SSI decision making through their more consciously chosen behaviors (De Boer, 2000; Hodson, 1998, 2003; Roberts & Bybee, 2014).

In line with the contemporary more societal position of scientific literacy, Lederman and Lederman (2014) have defined scientific literacy as understanding of the content of science as well as knowledge of how that content was developed, and the ability to make decisions using that knowledge and understanding. In accordance, the United States National Center for Educational Statistics (2011) has defined scientific literacy as “the knowledge and understanding of scientific concepts and processes to be used for personal decision making, participation in civic and cultural affairs, and economic productivity.” This encompassing view of scientific literacy embraces all different dimensions and requires understanding and collaboration between areas such as economics, politics, ethics, health, environment and politics. Based on factual and procedural scientific knowledge, this multidimensional view of scientific literacy could enable people to act in a more considerate way when faced with an SSI-related issue.

However, Miller (2012) has pointed out that this multidimensional view of science literacy could also lead to less agreement on SSIs, and may in fact lead to more polarization. One study, for example, has shown that SSI-related decision-making is subordinate to ethical judgments, economic concerns and personal value systems (Albe, 2008b; Kolsto, 2000b). Also, other studies have indicated some of the other variables that affect SSI decision making, such as personal and religious values, perceived knowledge (Jang 2013; Slovic, 2007), personal experience (Albe, 2008; Kahneman, 2011), ideas about the nature of science (Sadler et al., 2004), ethical convictions (Sadler, 2004), and the individual's capacity to empathize with the people affected by SSIs (Simonnaeux & Simmonnaeux, 2009). Further, a study by Fernstein (2014) has argued that engagement of lay people with SSIs is subordinated to their personal goals, while Nielsen (2012) has found that lay people use scientific evidence to support their personal view rather than to examine it critically. All of these findings highlight the multidimensionality of SSIs and the complexity of a public perception approach.

Hence, given the multidimensional aspect of SSIs, the skills and practice necessary for good critical thinking and communication become crucial when working on SSI-related context. Whether it is conversations or reading or listening to news, if the opposing groups have not developed the cognitive capacity to understand the background and mindsets of the other group, understanding between groups would be limited, leading to conversations between groups to be more like combat instead of a means of truly working together. On the other hand, if the right attitude is present, it could enable true understanding of differing groups that may well be the beginning of a conscious, informed conversation among the parties involved, hopefully leading all to a path of greater truth and consensus.

Thus, in addition to enhancing context or procedural scientific literacy, and a common awareness of the multidisciplinary nature of SSIs, it is necessary to create a solid foundation of critical thinking and wholesome communication by integrating necessary practices into the general education curriculum. On that account, the National Research Council (1996) offers National Science Education standards for considering engagement with science issues in the press; its decision to include reading, understanding and critical thinking of science issues reported in the press as part of the definition of science literacy is a promising step to produce citizens well equipped for understanding and interpreting evidence as adults, as well as working with the related controversies.

Given this background, in this research I looked at some direct and indirect sources of scientific literacy. I measured scientific literacy directly through science knowledge questions, which refer more to the content aspect of scientific literacy. Also, I looked at science-education and general-education levels to indirectly measure a broader scientific literacy, one that includes both the content and procedural nature of scientific literacy; in the last few decades, studies by Miller (1987, 2002, 2016) have indicated that civic scientific literacy is related to the level of educational attainment and exposure to college-level science courses. Lastly, I investigated the degree that people keep up with science news through media. The next section will look at that, followed by science education and general education.

Keeping up with Science News

The rapid scientific developments in the twenty-first century have put the public in a position where they need to understand and make decisions about scientific inventions that ultimately affect them and all society. For the public to respond critically to news about SSI-related innovations, scientific literacy is essential. Many sources help build up scientific literacy, but general education and more specifically science education in schools tend to be the main outlet. In addition, media, including television, radio, newspapers, and internet sources including social media, also pose as important outlets for the public in keeping up with developments in science. For example, Shearer and Gottfried's (2017) research has indicated that about 67 percent of Americans read some portion of the news, including science news on social media like Facebook and Snapchat. Nevertheless, making clear sense of the ubiquitous science news in the media can be challenging and confusing for the public, as the information shared is not necessarily peer-reviewed, and therefore requires an advanced understanding of science and knowledge about the goals of journalism.

Even the most rigorous journalistic practices may be faulty. First of all, journalists usually are not experts in the area of science they may be writing about. They may have basic schooling in science, and sometimes may have attended a few science workshops to familiarize themselves with certain scientific issues (McClune & Jarman, 2010). Anyone who has a strong background in science knows how much work and time goes into developing a comprehensive understanding. Therefore, it would not be off-target to say that journalists writing about science issues usually do not have a firm and rooted understanding of the issues they are writing about. Secondly, journalists follow the intrinsic goals of journalism: to attract the reader, listener, viewer, to make news accessible (Lewis, 2003), and guide the perception of their audience with sometimes involving manipulation and persuasion (Raeh, 2002). Due to this, the science news articles written by journalists are usually limited by their choice of wording, their choice of the angle from which they approach the SSI in hand, and how much detailed comprehensive information they share.

Further, journalists may have their own opinions about certain issues and often infuse them into their articles without being objective (Jarman & McClune, 2007). Jarman and McClune (2007) indicate that the headlines of an article, for example, are usually chosen by the editors, who base their choice on the journalist's article rather than from the primary source of information. Naturally, this could lead to the goals of journalism overriding the objective findings of science. In addition, publishing an article by a certain time with word limits puts further constraints, which may lead to mistakes, errors and lack of detail, discrediting the validity of the scientific claim and affecting the interpretation of an article by readers. McClune and Jarman (2012) have indicated that many science news reports have bias, false evidence, faults and overstatements.

In addition, media managers may have conflicting interests in how certain information is conveyed to the public, and place pressure on the editors for financial or ideological reasons. Editors can manipulate public perception through their choice of what types, how much, and in what ways they share evidence with the public. Exposure to conflicting scientific information can weaken the scientifically valid claims and evidence, as well as any public intention to act on the scientific facts by increasing skepticism and perceived uncertainty (e.g., Corbett & Durfee, 2004; Dixon & Clarke, 2013b; Dixon et al., 2015; Kortenkamp & Basten, 2015). Other researchers have indicated that exposure to conflicting scientific arguments moderates beliefs (e.g., Corner et al., 2012; Greitmeyer, 2014; Chang, 2015; Dixon & Clarke, 2013a, 2013b). For example, exposure to contradicting scientific views about autism and vaccination resulted in increased skepticism, uncertainty and change of beliefs with regards to these issues (Dixon & Clarke, 2013b). So, editors are in a position where they could alter the public perception of a controversial issue by their choice and frequency of the news they share with the public

Moreover, the perception of expert consensus (or apparent lack thereof) affects the public perception of controversial issues (Brewer & McKnight, 2017; Clarke et al., 2015; Cook & Lewandowsky, 2016; Dixon, 2016; Van der Linden, Clarke et al., 2015; Van der Linden, Leiserowitz et al., 2015; Corbett & Durfee, 2004; Jensen & Hurley, 2012). “Expert consensus perception” refers to the extent to which experts working in fields relevant to a scientific issue agree or disagree on a particular issue. Kobayashi (2017) has shown that perceived expert consensus served as a mediator in moderating participants’ beliefs about the controversial issues, increasing skepticism and perceived uncertainty. Again, journalists and/or editors have the power to manipulate the public perception of news by how much of the expert consensus (or non-consensus) they share with the public.

Hence, these limitations linked to the intrinsic nature of journalism pose a problem for public perception and decisions concerning SSI, and SSI-related innovations. In fact, Gomez-Zwiep (2008) proposed media itself as one of the sources of students' science misconceptions. Hence, it becomes even more important that the public as discerning individuals evaluate SSI-related news with a scientific literacy that includes critical thinking.

One of the tenets of critical thinking is to be able to view the pros and cons of an idea and to think them through. Critical thinking is a foundation of scientific thinking, and it is sensitive to context, relies on criteria and is self-correcting (Lipman, 1987). This is a quality found in skilled thinkers including respectable scientists and researchers (Paul & Elder, 2008). There is plenty of research done on college-level students about student evaluation of science-based news (Kolsto et al., 2006; Korpan et al., 1997; Korpan et al., 1999; Korpan et al., 2000; Norris & Phillips, 1994; Norris et al., 2003; Phillips & Norris, 1999; Ratcliffe, 1999; Ratcliffe & Grace, 2003). One of the findings is that evaluation of science news is different for articles about SSIs than for articles about scientific claims. This seems to indicate that the public utilizes different aspects of scientific literacy when evaluating SSIs based on the strength of their science background.

Kolsto et al. (2006) investigated students with a strong science background, and found that they were able to evaluate SSIs using a holistic perception of the nature of science, which included a focus on the scientific ideas, methods, theories as well as social aspects of the SSI evaluated. In Kolsto et al.'s research, scientific ideas, methods and theoretical aspects of scientific literacy were considered as the contextual and procedural nature of science. In contrast, social aspects of scientific literacy were defined as the existence of personal interest of writers, recognition of cited experts, and consensus among experts related to the issue. As for participants with a deficient science background, research on college students has indicated that non-science majors had only limited skills for critical analysis of scientific reports (Philips & Norris, 1999, 2012; Korpan, 1997).

For example, Philips and Norris (1999) indicated that students did not seem to have a good science base to build solid critical arguments of news reports they were reading. Students struggled with distinguishing between false and true evidence for science claims (Norris & Philips, 2012). Korpan et al. (1997) showed that students assessing a science claim who did not have a strong science background were able to focus on the methods and theories related to the claim, but not the social multi-perspectives involved. Further, Leung et al. (2015) investigated 38 students with non-science backgrounds, and showed that non-science majors were more likely to refer to methods and theories, but not as much the social aspects of the scientific claim. McClune and Jarman's (2010) research involving detailed interviews with many experts from areas of science and media education and journalism, echoed this conclusion, finding that indicated knowledge of scientific ideas and methods was necessary for critical analysis of science news. It seems that college-level students of non-science background do have the skills for basic critical analysis of science news involving scientific claims, but these same findings also indicate the struggle of non-science majors with critical analysis of the social aspects of scientific news. Considering the fact that SSIs are richer in their social context by nature, subsequently one wonders about the ability of college students or the public's general ability to critically analyze scientific reports involving SSIs.

Leung et al. (2015) have shown that non-science major college-level students were more apt to focus on the social aspects of an SSI when they were evaluating an article about an SSI, rather than methods and theories. The same participants, however, adhered to science ideas and methods when evaluating science news based on scientific claims. As a possible reason, researchers pointed out that the SSI article used in their study was lacking in experimental details, which could have left participants without enough material for critical analysis of the related scientific ideas and theories, potentially affecting their findings. Further, they indicated that the complex nature of SSIs could have prompted participants to be more aware of the many perspectives involved with regard to the SSI. Contrary to non-science majors, science majors seemed to be able to draw upon their science ideas and methods when confronted with an SSI, and outperform non-science majors with the depth, broadness and comprehensiveness of their arguments (Sadler & Fowler, 2006; Willingham, 2007; Bråten et al., 2011).

These findings point to the different nature of the evaluation of SSI-related science news by the public, and they bring up the question of how much science education affects the critical evaluation of SSI-related articles. Nevertheless, it must be noted that all of the above-mentioned studies used written texts as science news reports, and did not include visual media or social media elements—e.g., videos, comments or like/unlike buttons. These different means of information dispersal could likely have a different effect on the evaluation of science reports by the viewers. Seeing other people's comments, for example, could create social pressure to follow the trend perspective rather than their own perspective. Also, generally, in these studies the science reports chosen for analysis were generally health-based. More abstract topics such as energy, physics or space could again lead to a different evaluation, as the participants may have less direct experience to draw their opinions from. Therefore, one must be careful generalizing these findings to all SSIs, and it is very clear that more comprehensive research is needed in this area.

The next section will look at the relationship between science education and its relationship to the perception of SSIs.

Level of Education

Level of Science Education. Over the last few decades, there has been an evolution in the main goals of science: from science as a means of preparing future scientists and engineers, and instead towards science as a means of preparing future citizens with the capacity and skills to actively participate in democratic decision making for a better future (Aikenhead, 2005; Bybee, 1993; Roberts & Bybee, 2014). This trend is apparent in recent education programs like Next Generation Science Standards (NGSS), and movements such as the Science, Technology and Society Movement (Albe, 2008) and Socially Acute Questions movement (Simonneaux & Simonneaux, 2009). These movements have focused on the use of complex scientific issues to promote learning science content, and engage in citizen education by means of multidisciplinary lenses in discussion of these issues (Barrue & Albe, 2013; Kolsto, 2001). Using multidisciplinary lenses forces one to think holistically about all the factors affecting the issue at hand, increasing the possibility of a solution that works for all.

NGSS, for example, has integrated Disciplinary Core Ideas (DCIs) with Science (SEPs) and Engineering Practices where Crosscutting Concepts (CCs) in K-12 are included (National Research Council [NRC], 2013). DCIs include a domain of engineering, technology and applications of science in addition to the traditional content areas of physical life, Earth and space sciences. The SEPs, in comparison, focus on analysis and interpretation of data like that of a scientist and engineer in their daily work. The CCs have a more multi- and inter-disciplinary aspect focusing on connections and relationships between different disciplinary and content areas (NRC, 2012). These developments are in line with the arguments that emphasize interconnectivity in science curricula between science, environment, health and society to prepare students for daily issues as an active citizen (Dillon, 2012). The NGSS, for example, expects that students will be able to criticize and make sense of science-related daily issues after finishing high school (NRC 2011).

Further, being able make lifestyle choices about SSIs, such as reducing one's carbon footprint or increasing sustainability, has been an expectation of science educators all over the world (e.g., Feinstein et al., 2013; Jenkins, 1999; Roth & Lee, 2004; Australian Curriculum, Assessment and Reporting Authority [ACARA], 2014; Department of Education, 2015; National Research Council [NRC], 2011; Organization for Economic Co-operation and Development [OECD], 2014). Particularly, the importance of actively making decisions about SSIs as daily applications of science has been highlighted internationally by many science educators, researchers and scientists (e.g., AAAS, 1991; National Research Council, [NRC], 1996). However, there is little evidence this is happening particularly in regards to SSIs such as Feeding the World's Population, Climate Change, Diseases, and Clean Water, to name a few (Feinstein, 2011). It must be emphasized that taking no action regarding SSIs has its own consequences, which can be as harmful as actions on misinformation or beliefs. According to Linder and Wickman (2007), the lack of scientifically literate citizens prevents clarity on some of the less controversial SSIs and keeps them from being prioritized. Research indicates that most undergraduate science courses and curricula de-emphasize SSIs, due to a transmission model of education where specific content is transferred to students through lectures and labs (DeHaan, 2005; Wyckoff, 2001; Cooper & Kerns, 2006). Although a 2014 Pew study has found that while members of the AAAS have a positive attitude towards scientific innovation and trust in scientific evidence regarding SSIs, the general U.S. public does not (Pew, 2014). This is why more research is needed in investigating the relationship between science education and attitude towards SSIs.

On the other hand, some educators and researchers have taken SSIs as a vehicle for better education and have integrated them into their pedagogy and curriculum, or as separate courses. Several studies indicate positive results. Barrue and Albe (2013) found SSI instruction to promote citizenship, increase information literacy skills, improve argumentation and critical thinking, and increase the relevance of the perception of science, as indicated by science teachers. Similarly, Bryce and Gray (2004) found that by including SSI discussions in the curriculum, students report a better understanding of science. Fowler and Zeidler (2016) highlighted that the teaching of SSIs may provide an interest in the students for learning required science content, while also advancing critical thinking and scientific literacy. Kolsto (2006) found that critical examination of SSIs in science courses through writing about SSIs resulted in an increased self-awareness of competency in their knowledge claims, expert views, specialized content knowledge, and science methodological norms. Such findings that highlight improvements in SSI argumentation are particularly important in light of other research that indicates that students struggle when negotiating SSIs (Lee & Grace, 2012).

Despite these promising findings about the benefits of including SSIs as part of teaching, other research indicates resistance to it from science educators. Sadler et al. (2007) propose that this resistance could be due to the extra time and effort needed, whereas Roberts (2007) thinks it could be due to the misconception that fundamental science content will not be covered properly.

Moving beyond science education in specific, the next section will investigate the level of general education.

Level of General Education

Research investigating the understanding of interdisciplinary science indicates a trend across different grade levels (Yang et al., 2017), showing that students' understanding of interdisciplinary science increases from grades 4-6 and from grades 7-8, but sharply decreases between grades 6-7. Liu (2007) has also indicated a steady increase in mean interdisciplinary science scores from elementary to high school. Similarly, Smith et al. (2006) also found a learning growth curve for elementary and middle school students. While these studies are all cross-sectional and use different measurement tools, so their findings cannot be generalized, they do indicate a positive correlation between level of education and understanding of science.

For example, one study (Eggert & Bogeholz, 2009) developed a test instrument that could be used among different age groups from lower secondary school to university undergraduates, and found an increase in decision-making competency with years of general education. However, the same study was not able to find any increase in personal decision making ability from 8-10 years of education and 12 to university level. Similarly, Yang et al. (2018) found insignificant growth by students from grades 4 through 6. Two of the difficulties in doing such research are interdependent sampling and using the right measurement tools from the perspective of development. Longitudinal data sets could be used and are needed for a better understanding of student learning growth across time, particularly with respect to interdisciplinary topics.

Another way to overcome these difficulties is to use a sample that is beyond these developmental stages, and look at the influence of each educational development stage by means of general education level. This can be measured by the highest level of education one has received. In line with the need for research in this area, this study will use a sample that is beyond these developmental stages, i.e., adults 18 years and above, and investigate the relationship between years of general education and attitude towards SSIs and scientific innovations. Further, part of this study focuses on a highly educated rural area surrounded by millions of acres of Adirondack State Land, which is a highly protected natural area in the continental U.S. Data collected from this area enables perceptions of residents from a small rural area to be acknowledged in relation to SSI related innovations.

Overview of the Research Design

The current research is comprised of two parts: Study 1 and Study 2. Both of which looked at some of the factors relating to public perceptions of SSI-related innovations. Study 1 investigated the relationship between scientific knowledge, general education level, whether the person holds a science degree, and the resulting perceptions of SSI-related innovations in the fields of energy, health, space, human evolution and climate. In addition, Study 1 explored the current SSI of the Covid-19 pandemic and the use of the Covid-19 vaccine, and it surveyed a highly educated small rural area that has many opportunities for strong connection to nature. Study 2 similarly looked at the relationship between scientific knowledge, general education level, and the perception of SSI-related innovations in the fields of energy and health. Study 2 also investigated the association between frequency of keeping up with science news and the perception of SSI-related innovations in the areas of energy and health. The two studies differed also in their samples (Study 1 focused on a rural area in Upstate NY, while Study 2 included participants from all across the United States) and research methodology (Study 1 was an online questionnaire with items adapted from the Pew Research Center research, and Study 2 was a secondary data analysis of a 2014 Pew study).

Hereafter, Chapters three and four will elaborate on the research design, method, participants, protection of human rights, instrumentation, procedure, results, and discussion for each study.

Chapter 3

Study 1

Study 1 (*N*=162) examined the perception of socioscientific issues' related innovations in relation to science knowledge, general education level, and whether the person holds a science degree. Socio scientific issues, abbreviated as SSIs in this study are defined as controversial issues related to science (Zeidler & Keefer, 2003) that need a holistic understanding of the issue in connection to economics, ethics, morality, and politics. Examples of SSIs would be global warming, use of vaccines, genetic modification of food, or animals, etc. Study 1 also investigates predictors of using a newly invented Covid-19 vaccine, in line with the current SSI of the Covid-19 pandemic. The dependent variables are perception of SSI-related innovations with regards to energy, space, health, evolution of human and climate, and use of Covid-19 vaccine. Independent variables are science knowledge, general education level and whether the person holds a science degree. Predictors for the outcome variable using a Covid-19 vaccine are science knowledge, general education level, whether the person holds a science degree, and having knowledge of scientists' treatment of Covid-19. This is a non-experimental study based on online self-reported questionnaires. It is correlational in nature.

Hypotheses

Four hypotheses were tested:

H1: People who have higher levels of scientific knowledge will have perceptions that favor SSI-related innovations compared to people with lower levels of scientific knowledge.

H2: People who have higher levels of education will be in favor of SSI-related innovations compared to people with lower levels of education.

H3: People who have science degrees will be in favor of SSI-related innovations compared to people with lower levels of education.

H4: Science knowledge, general education level, holding a science degree, knowledge that the scientists have a clear understanding of treatment, and favoring of health-related innovations are predictors that can be used to predict a person's agreement on the use of a Covid-19 vaccine, even though all phases of the medical trials for this vaccine are far from conclusive.

Relevant Variables and Measures used for Each Research Question

Research Question 1: What is the relationship between one level of scientific knowledge and the perception of SSI-related innovations?

Measures for R1: Scientific knowledge, the perception of SSI-related innovations in four subcategories (Health, Space, Energy, Evolution)

Research Question 2: What is the relationship between one's level of education and the perception of SSI-related innovations?

Measures for R2: Level of education, perception of SSI-related innovations in four subcategories (Health, Space, Energy, Evolution)

Research Question 3: What is the relationship between having a science degree or not, and one's perception of SSI-related innovations?

Measures R3: Having a science degree or not, perception of SSI-related innovations in four subcategories (Health, Space, Energy, Evolution)

Research Question 4: What are the predictors of using a new Covid-19 vaccine even though all clinical trials have not been completed?

Measures R4: Level of education, having a science degree or not, science knowledge, knowledge that the scientists have a clear understanding of treatment of Covid-19, and favoring of health-related innovations

Method

Participants

Adult participants (*N*=162), aged 18 years or above, U.S. citizens or legal U.S. residents from the Towns of Keene and Jay in Essex County, Upstate New York. This area was chosen due to its unique position of being surrounded by millions of acres of highly protected Adirondack state land, and also its highly educated residents. They were recruited online by a message posted to Nextdoor Keene and Jay News, both social platforms. Nextdoor Keene has about 1200 participants who need to be residents of the Town of Keene or the nearby hamlet of Keene Valley in order to be members. Jay News has about 2400 members that also included people from Keene, Keene Valley and Jay. The three towns have a similar lifestyle, different from other towns in the northern Adirondack area of New York State, in terms of higher income levels, higher levels of education and more democratic inclined political views as indicated by 2020 Census Data. These online posts contained an invitation to participate in a study of "Public Perception of Socio-scientific Issues".

Protection of Human Subjects

This study was approved by the Claremont Graduate University International Review Board (Appendix III). The survey questions were set as anonymous in the Qualtrics software, meaning there were no questions that could be used as identifiers for the participants. Further, coded information from this survey has been protected in all papers, books, talks, posts, or stories resulting from this study. For further protection of confidentiality in data collection, extra measures have been taken, such as securing data files, using random ID codes or pseudonyms, and reporting only averages or other group statistics. Also, participation was voluntary, and data collection and storage posed no harm to participants.

Procedure

Information about the study was posted on the Nextdoor Keene social platform with a link to an online consent form that consequently led to the survey. A similar post was also created for the email based online social platform Jay News and was posted 3 weeks after the Nextdoor Keene post. The posted details informed the participants that this study was designed to explore perception of SSIs. Participants were also assured of confidentiality and anonymity. The message indicated that participants were eligible for a gift card drawing of $100 value for Amazon or a local shop if they sent a separate message to an indicated email address. Once the informed consent was completed, participants were able to access the online survey, which took approximately eight minutes to complete and included the materials described below. Two questions checked the age of participants as equal to or older than 18 and that they are U.S. citizens or legal U.S. residents. Then questions assessed the following: perceptions of SSI-related innovations, science knowledge questions, and demographic information. Reposts on the social platforms were conducted to ensure a sufficient number of participants, with an additional motivational update of a 20 percent bonus in the gift card drawing. Sixty-six persons participated in the gift drawing, and one participant was selected to collect the gift.

Materials

The online questionnaire was created based on items selected from a 2014 Pew Research Center survey and was adapted for the purpose of this research. The questions selected were related to public perception of SSIs and SSI-related innovations. Four new questions addressing the Covid-19 pandemic were added as an example of a current SSI that was relevant at the moment of data collection. The survey took about 8 minutes to complete and consisted of 39 questions probing participants' perception on SSI related innovations on four subcategories of health, space, energy and evolution of human and nature. The survey also had six questions about science knowledge and twelve demographic questions asking respondents about their birth date, race, education level, science education level, income, employment status, number of people in their household, and political ideology and affiliation.

Measurements

The following paragraphs will explain the related questions and their scoring.

Science knowledge was measured using five multiple choice questions and one true-false question taken from 2014 Pew research, and all were based on factual knowledge of a range of science topics such as antibiotics, lasers, nanotechnology, chemical reaction, red blood cells and gases that potentially cause climate warming. An example question is "Which of these is a major concern about the overuse of antibiotics?" Participants answered questions online by clicking on one of the multiple-choice boxes (the correct answer, incorrect answer, or do not know/did not answer). An overall science knowledge count ranging from 0-6 was created using the science knowledge answers by giving "1" point to each correct answer and "0" points to each wrong answer. A person who answered all questions wrong would get 0 points and one who answered all questions correctly would get 6 points.

General education level was assessed by one question taken from the 2014 Pew research asking about the highest degree of education obtained, stated as, "What is the highest level of school you have completed or the highest degree you have received?" A value between 1-8 was given, with 8 being the highest for "Postgraduate or professional degree, including master's, doctorate, medical or law degree (e.g., MA, MS, PhD, MD, JD, graduate school) and 1 being the lowest level of education "Less than high school (Grades 1-8 or no formal schooling)." A value of 9, "Don't know," or refusal to answer, was treated as missing data.

Holding a science degree or not was measured by one question taken from the 2014 Pew research, which asked if the college, university, or graduate degree was science-related. This question was part of the previous one, asked only if the respondent indicated that they attended a college or higher level of education. If the participant indicated that they received a science degree, it was coded as 2, while not having a science degree was coded as 1. Missing or "Don't know" answers were treated as missing values.

Perception of SSI-related innovations was assessed with 24 questions from the 2014 Pew Research report and divided into four subcategories, including perception of health-related innovations, perception of space-related innovations, perception of energy-related innovations, and perception of evolution-related issues.

Perception of health-related innovations included 13 questions asking whether the respondent favors/agrees or opposes/disagrees with health-related innovations such as genetically modified foods, foods grown with pesticides, genetic modification of fetuses and viruses, biological engineering of organs, vaccination experiments, use of animals for research, use of drugs before fully tested, the existence of Covid-19, and vaccinations and drugs for Covid-19. An example is, "Thinking about the use of biological engineering to create artificial organs for humans needing a transplant operation, would you say this is making appropriate use of medical advances OR is it taking medical advances too far?" Answers were assessed using a Likert scale with 1 representing "strongly oppose" and 5 representing "strongly favor," and 9 if the person did not answer, which was treated as a missing variable. A mean score was computed making sure missing data was not included.

Perception of space-related innovations consisted of two questions asking whether the respondent agrees or disagrees with space-related innovations, such as the International Space Station and use of machine astronauts in place of human astronauts. An example question was, "The cost of sending human astronauts to space is considerably greater than the cost of using robotic machines for space exploration. As you think about the future of the U.S. space program, do you think it is essential or not essential to include the use of human astronauts in space?" Answers were given on a Likert scale ranging from 1 "strongly disagree" to 5 "strongly agree," and 9 if the person did not answer. A mean score was computed.

Perception of energy-related innovations was comprised of four questions asking whether the respondent favors or opposes energy related innovations such as use of nuclear energy, fracking, offshore drilling, and the use of genetically modified plants for liquid fuel. An example was, "The increased use of genetically modified plants to create a liquid fuel replacement for gasoline." Answers ranged from 1 "strongly oppose" to 5 "strongly favor," and 9 if the person did not answer. An average score was computed.

Perception of evolution of human- and nature-related innovations included 5 questions probing participants' convergence or divergence on human- and climate/evolution-related statements. An example question would be, "Which of these three statements about the Earth's temperature comes closest to your view?" with two possible answers to choose from: "The Earth is getting warmer mostly because of human activity such as burning fossil fuels." or "The Earth is getting warmer mostly because of natural patterns in the Earth's environment." Answers involving evolution as a natural event were given a value of 5, while answers indicating other factors causing evolution were given a value of 1, and 9 if the person did not answer. The last two questions of this scale involved two questions that were measured in a Likert scale, where 5 indicated strong agreement about evolution being natural, and 1 indicated strong opposition to evolution being a natural phenomenon. A mean score was computed for questions 4 and 5.

Knowledge that the scientists have a clear understanding of treatment of Covid-19 was measured by the question "From what you've heard or read, would you agree that scientists have a clear understanding of how to treat the Covid virus? " A value of 1 point was given if the participant strongly disagreed, 2 points if they disagreed, 3 points if neutral, 4 points if they agreed, and 5 points if they strongly agreed. If the participant did not answer the question, it was coded as 9.

Demographics questions included birth date (age), sex, race, income, employment and marital status, number of people living in their household, and political ideology and affiliation.

Results

Descriptive Statistics

Participants

Participants were 63.6 percent females and 32.7 percent males, and ranged in age from 19 to 91 years. The mean age was 57.7 years *(SD* = 15.74*).* The majority of the participants identified themselves as white, as shown in Table 1 below.

Table 1

Race Frequencies

Race	Percentage
White	87
White & American Indian or American-Alaskan	3.7
Other	1.2
Hispanic, Latino or Spanish	0.6
Black or African-American	0.6
White & American or Black	0.6
White & African-American, or Black & American Indian or Alaskan Native	0.6

Educational level was high, with postgraduate degrees at 45.7 percent. The median of the income reported was $75,000-$99,999 bracket, with 37.9 percent paid employees, 21.2 percent working as self-employed and 35.4 percent retired.

Political identification wise, most of the participants identified as Democrats, as shown in Table 2.

Table 2

Political Identification

Political Identification	Percentage
Democrat	52
Independent	23.6
Republican	11.8

Participants also reported on the Liberal-Conservative continuum, with 19.9 percent of participants identifying as Extremely Liberal, 44.7 percent as Liberal, 13 percent Conservative and 2.5 percent Extremely Conservative.

I will now report the descriptive statistics for main variables of interest: Science knowledge, general educational level, and holding a science degree or not. In addition, I have added a paragraph on Covid-19 related demographics.

Table 3

Frequency Table for Science Knowledge

Number of correct science knowledge questions	Frequency	Valid percent
3	8	5.0%
4	19	11.8%
5	36	22.4%
6	98	60.9%
Missing	1	0.6%
Total	162	100%

Science knowledge amongst participants was high (*M* = 5.39, *SD* = 0.88) with 60.9 percent of participants answering all questions correctly, as shown in Table 3 above.

Table 4

Frequency Table for Incorrect Science Knowledge Answers

Number of science knowledge question	Number of incorrect answers	Valid percent of incorrect answers to the particular question
Q1_ Antibiotics	5	3.1%
Q2_ Lasers	52	32.7%
Q3_ Nanotechnology	18	11.1%
Q4_ Chemical reaction	9	5.6%
Q5_ Red Blood cells	6	3.8%
Q6-Global warming gas	8	5.0%

The questions which participants relatively struggled most were the ones about laser technology with 32.7 percent incorrect answers, and nanotechnology with 11.1 percent incorrect answers as shown in table 4 above. This finding was in line with the high education level of the participants.

Table 5

Frequency Table for Education Level

Education level	Frequency	Valid percent
Full postgraduate/professional degree	55	34%
Some postgraduate degree	19	11.7%
Four-year college or university degree	47	29%
Associate's degree	17	10.5%
Some college, but no degree	13	8.0%
High school degree	11	6.8%
High school incomplete	0	0
Less than high school degree	0	0

Conclusion: 74.7 percent of participants received a four-year college or university degree or higher as indicated in Table 5 above.

Table 6

Frequency Table for Education Level in Relation to Gender Affiliation

Education level	Male	Female	Other	
Full postgraduate/professional degree	16	38	1	55
Some postgraduate degree	6	12	1	19
Four-year college or university degree	20	24	3	47

Associate's degree	5	12	0	17
Some college, but no degree	3	10	0	13
High school degree	3	7	1	11
High school incomplete	0	0	0	0
Less than high school degree	0	0	0	0
Total	53	103	6	162

Conclusion: There was not a significant difference between males and females in terms of level of education.

Table 7

Frequency Table for Education Level in Relation to Political Affiliation

Education level	Republican	Democrat	Independent	Refused	Total
Postgraduate/professional degree	3	36	11	2	55
Some postgraduate degree	3	8	4	1	18
Four-year college or university degree	4	23	13	2	47
Associate's degree	5	6	4	0	17
Some college, but no degree	3	6	1	0	13
High school degree	1	5	5	0	11
High school incomplete	0	0	0	0	0
Less than high school degree	0	0	0	0	0
Total	19	84	38	5	162

Politically speaking, the distribution of identifying as a democrat, an independent or a republican was similarly distributed amongst different education levels (Table 7).

Table 8

Frequency Table for Education Level in Relation to Conservative-Liberal scale

Education	Ext. Cons.	Conservative	Neutral	Liberal	Ext. Lib.	Total
Postgraduate/ professional	0	4	10	25	16	55
Some postgraduate	2	1	5	7	3	18
College or university	0	7	7	26	7	47
Associate's	1	5	2	6	3	17
Some college	1	2	3	6	1	13
High school	0	2	5	2	2	11
High school incomplete	0	0	0	0	0	0
Less than high school	0	0	0	0	0	0
Total	4	21	32	72	32	161

In terms of placement on the Extreme Conservatism and Extreme Liberalism scale, the distribution with respect to education level was again similarly distributed, as shown in Table 8 above.

Table 9

Frequency Table for Education Level in Relation to Race

Education level	White	Hispanic	Black	White & Black	White & Native	Total
Postgraduate/professional	46	0	1	0	3	50
Some postgraduate	14	0	1	0	1	16
College or university	46	0	0	0	0	46
Associate's	13	1	0	1	1	16
Some college	12	0	0	0	1	13
High school	10	0	0	0	0	10
High school incomplete	0	0	0	0	0	0
Less than high school	0	0	0	0	0	0
Total	141	1	1	1	6	150

Considering the relatively small number of people who identified as not white only, the ratio of non-white-only postgraduate degree holders were similar to those who identified as white only (Table 9).

Regarding demographics of science degree holders, only 29 percent of the participants indicated a degree related to science, with 42.5 percent of these science degree holders having a post graduate degree, 27.5 percent a Bachelor's degree, and 17.5 percent a two-year Associate's degree.

Of the science degree holders, 52.5 percent identified as Democrats, 27.5 percent as Independents, and 12.5 percent identifying as Republicans. Only 10 percent of the science degree holders identified themselves as Conservative, 2.5 percent as Extremely Conservative, 52.5 percent as Liberal, 17.5 percent as Extremely Liberal, and 17.5 percent as neutral. Fifty percent of the science degree holders indicated an income above $100,000, with 10 percent indicating an income between $74,999 and $99,999, and 20 percent indicating an income between $50,000 and $74,999. Only 7.5 percent of the science degree holder participants who indicated they were not white.

Next, this report explored demographics related to perceptions of SSI in four domains of energy, space, health, and evolution.

Participants on average tended to oppose energy-related SSI innovations with a mean of 2.24 (SD = .794), where 1 represents strong opposition, 2 represents opposition, 3 represents neutral, 4 represents favor, and 5 represents strongly favor. Only 13.6 percent of participants had average scores higher than 3, which indicates favoring of energy-related SSI innovations.

Table 10

Mean and Standard Deviation for Energy Variables

Energy-related SSI	M	SD
Nuclear	2.4	1.22
Fracking	1.74	1.04
Genetically modified plants for fuel	3.05	1.19
Offshore oil and gas drilling	1.75	0.97

As shown in Table 10 given above, fracking and offshore oil and gas drilling received the most opposition, while nuclear plants received some opposition, and contrarily the use of genetically modified plants to create oil fuel approached a favorable perception.

Table 11

Mean and Standard deviation for Space-Related Variables

Space related SSI	M	SD
Space station	3.56	.88
Robot only Astronauts	2.61	1.06

As for perception of space-related SSI-related innovations, the participants indicated a somewhat favorable overall perception (M = 3.08, SD = .50). As shown in Table 11 above, the results indicated that participants were in favor of a space station, but they were in slight opposition to use of only robotic machines as opposed to human astronauts in space exploration; only 24.2 percent of participants in favor of not having human astronauts in space exploration.

Since perceptions of health-related SSI innovations were assessed with 13 questions across a wide range of topics, they are reported thematically below. Two items were taken out due to skewness and kurtosis.

Table 12

Mean, Standard Deviation and Percentage Favoring or Opposing Health-Related Variables

Health Variable	Mean	Standard Deviation	Percentage	Favor or Oppose
Access to experimental drugs before clinical trials finished	3.15	1.00	39.5%	Favor
Engineering and use of artificial organs	3.85	.98	72.8%	Favor
Changing fetal genes to enhance	1.55	.95	24.6%	Favor

intelligence				
Use of animals in research	2.65	1.14	75.3%	Oppose
Perceive foods grown with pesticides as safe/unsafe	2.17	1.08	17.2%	Perceived as safe
Perceive genetically modified foods as safe/unsafe	2.84	1.14	27.8%	Perceived as safe

Perceptions related to Covid-19 were also reported.

Table 13

Mean, Standard Deviation and percentage of Covid-19 related health variables

Covid-19 related health variable	Mean	Standard Deviation	Percentage	Favor/Agree or Oppose/Disagree
Covid-19 pandemic really exists	4.82	.45	98%	Agree
Perceive	3.15	1.07	45.7%	Favor

current Covid-19 treatment as safe				
Using the new Covid-19 vaccine even though experimental trials are not completed	3.35	1.15	51.6	Favor
Genetic modification to alter makeup of viruses	2.86	1.10	28.4%	Favor

For the field of evolution-related SSIs, findings indicated that 93.8 percent of the participants believed human evolution to be a natural phenomenon (*M* = 4.50, *SD* = .74), while climate evolution as global warming was perceived by 88 percent to be a human-caused evolution (*M*=1.47, *SD*= .93).

Lastly, before starting statistical analysis, I have reported findings on the statistical check for outliers for all variables of interest that were on a continuous scale, by looking at skewness and kurtosis. When all items were checked, only 11 items displayed skewness and kurtosis above

1 or below -1. Skewness results above 1.2 or below -1.2 were accepted as normal, and were continued with related statistical analysis as long as the relevant kurtosis was also within -1 to 1 range. After this check, only 7 items were left with out-of-range skewness and kurtosis scores. These items are listed in table 14 below.

Table 14

Table of Out-of-Range Skewness and Kurtosis Values

Variables with out-of-range skewness & kurtosis values	Skewness	Kurtosis
Fracking	-1.351	.968
Fetal gene alteration	2.084	4.255
GMO foods	1.519	1.592
Covid-19 being real	-3.093	11.553
Scientists’ consensus on human evolution	-1.824	2.885
Scientists’ consensus on global warming	-1.778	2.650
Science knowledge	-1.612	2.548

As a next step, these 7 items were checked for outliers using frequency tables and histograms. Findings indicated that amongst these 7 items, only 4 items—namely, fracking, science knowledge, Covid-19 as real, and knowledge on scientists’ consensus on human evolution had data that could be treated as outliers. Outliers in these 4 items were replaced with the best near-good data as part of Winsorization, and the items were checked again for skewness and kurtosis. Three items about fetal gene alteration, checking food for genetic modification while shopping, and scientists' consensus on global warming, found no outliers to explain their out-of-range skewness and kurtosis values, and were taken out of further analyses. The four items whose outliers were removed had new outputs given in Table 15 below.

Table 15

Table of New Skewness and Kurtosis Values for Variables after Removal of Outliers.

Variables with out of range skewness & kurtosis values	Skewness	Kurtosis
Fracking	-1.174	.963
Covid-19 being real	-1.999	2.023
Scientists' consensus on human evolution	-1.630	1.606
Science knowledge	-1.293	0.671

Amongst these four items, fracking and science knowledge had new skewness and kurtosis values that enabled them to be accepted for further analyses, while items Covid-19 and human evolution were taken out of further analysis, as they still could not meet normality requirements.

The next section will continue with Hypothesis testing, including only items that passed the skewness and kurtosis test.

Hypothesis Testing

Hypothesis 1

Table 16

Descriptive statistics for Science Knowledge, Perception of Energy-Related Innovations and Perception of Health-Related Innovations

Variable	**N**	**M**	**SD**
Scientific knowledge	162	5.36	0.92
Perception of fracking	162	1.72	0.96
Perception of safety of genetically modified food	162	2.84	1.10

$^{*}p < .05$, $^{**}p < .01$.

H1: People who have higher levels of scientific knowledge will have perceptions that favor SSI-related innovations compared to people with lower levels of scientific knowledge. Correlation analysis found no significant relationship between science knowledge level, and increased use of energy-related innovations, except for fracking $r = -.171$, $p < .05$, such that as science knowledge increased favoring of fracking decreased.

Further, there was no significant relationship between science knowledge level and space-related innovations.

In the category of health-related scientific innovations, there was no significant correlation with science knowledge level and health-related innovation questions, except for one question asking about the safety of eating genetically modified food, $r = .169$, $p < .05$. Results indicated that as science knowledge increased, agreement on the safety of eating genetically modified food also increased.

For third category of innovations, namely evolution of climate, no significant correlation was found between science knowledge level and knowledge about scientists' consensus as human activity being the main cause of global warming.

Hypothesis 2

H2: People who have higher levels of education will be in favor of SSI-related innovations compared to people with lower levels of education.

Table 17

Descriptive Statistics and Correlation Table For Education Level and Perception of Health-Related Innovations

Variable	N	M	SD
Education level	162	6.33	1.56
Perception of using animals for research	162	2.65	1.14
Perception of Covid-19 as an exaggeration	162	4.07	1.05

$^{*}p < .05$, $^{**}p < .01$.

There was no significant relationship between education level and increased use of energy- or space-related scientific innovations.

Similarly, there was no significant relationship between the increased use of health-related innovations and the level of general education, except for two items: using animals in research and Covid-19 as an exaggeration of an intense cold. Education level had a small positive significant relationship with the use of animals in research, $r = .160$, $p < .05$; such that when education level increased, favoring animal use in research also increased. As a second finding, when education level increased, the view that Covid-19 is not an exaggeration of a new intense cold significantly increased, $r = .215$, $p < .01$.

In the category of evolution of climate, no significant relationship was found between education level and knowledge about scientists' consensus as human activity being the main cause of global warming.

Hypothesis 3

H3: People who have a science degree will be more in favor of SSI-related innovations compared to people with no science degree.

Independent samples t test analysis with confidence level of 95 percent indicated no significant differences between groups of science degree versus no science degree holders in relation to energy- and space-related scientific innovations for fracking, plant fuel, offshore oil and gas, space-station investment and for robot-only astronauts. However, t test analysis indicated marginal significance with respect to nuclear energy, $t\ (136) = -1.930$, $p = .056$. Indeed, there were no significant differences between science degree holders and no science degree holders, except for nuclear energy. However, in order to disclose a full accounting of the statistics, please refer to Table 18 and Table 19 below for the means and standard deviations in each group.

Table 18

Cross Tabulation Table for Perception of Energy-Related Innovations with Respect to Science Degree

Energy	Science degree holders		No science degree holders	
	Mean	SD	Mean	SD
Nuclear	2.75	1.32	2.31	1.19
Fracking	1.80	.94	1.58	.94
Plant fuel	3.10	1.24	2.96	1.22
Offshore oil gas	1.85	1.08	1.65	.91

Table 19

Cross Tabulation Table for Perception of Space-Related Innovations with Respect to Science Degree

Space	Science degree holders		No science degree holders	
	Mean	SD	Mean	SD
Space Station investment	3.70	.91	3.57	.84
Robots-only astronauts	2.55	1.08	2.72	1.08

In the realm of health, independent samples t test analysis showed that science degree holders were in favor of using animals for research, M=3.03, SD=1.20 when compared to no science degree holders M=2.56, SD=1.11, $t(136)$= -2.166, p= .032. Also, science degree holders were favoring of genetic alteration of viruses M = 3.20, SD = 1.22, while people without science degrees were not in favor, M = 2.73, SD = 1.02, t (136) = -2.290, p = .024. Both science degree holders and no science degree holders indicated disagreement that foods grown with pesticides are safe to eat. However, those with science degrees indicated less disagreement on safety of pesticides, $M = 2.52$, $SD = 1.18$, when compared to no science degree holders, $M = 2.03$, $SD = 1.04$, $t\ (65.18) = -2.314$, $p = .024$. As for trust on scientists' knowledge of genetically modified food, science degree holders agreed that scientists had a clear understanding of genetically modified food, $M = 3.43$, $SD = 0.96$, while people without science degrees indicated disagreement, $M = 2.84$, $SD = 1.11$, $t\ (136) = -2.935$, $p = .004$. These findings can also be found in Table 20 given below.

Table 20

Cross Tabulation Table for Perception of Health-Related Innovations with Respect to Science Degree

	Science degree holders		No science degree holders	
Health	Mean	SD	Mean	SD
Use of animals for research	3.03	1.20	2.56	1.11
Genetic alteration of viruses	3.20	1.22	2.73	1.02
Safety of pesticides	2.52	1.18	2.03	1.04
Knowledge that scientists have a clear understanding of genetically modified food	3.43	.96	2.84	1.11

For the other health-related items, independent-sample t test analysis with a confidence level of 95 percent indicated no significant differences between groups of science degree versus no science degree holders in relation to experimental drugs, artificial organs, genetically modified food, Covid-19 as exaggeration, and Covid-19 treatment. Indeed, there were no significant differences between science degree holders and no science degree holders with respect to these items; however, for full disclosure of statistics, please look at Table 21 given below.

Table 21

Cross Tabulation Table for Perception of Health-Related Innovations with Respect to Science Degree

Health	Science degree holders		No science degree holders	
	Mean	SD	Mean	SD
Use of experimental drugs	3.25	1.01	3.03	1.03
Use of Covid-19 vaccine	3.58	1.09	3.22	1.21
Bio engineered artificial organs	4.00	.91	3.76	1.00
Use of genetically modified food	3.13	1.34	2.74	1.03
Belief that Covid-19 is an	4.38	.90	4.01	1.07

exaggeration of a cold				
Knowledge that scientists are clear about Covid-19 treatment	3.42	1.06	3.08	1.08

Lastly, my analysis found no significant difference between science degree holders and no science degree holders with regards to knowledge about scientists' agreement on human activity as main cause of global warming. In fact, results indicated no significant difference between science degree holders and no science degree holders with respect to scientists' agreement on human activity as the main cause of global warming. The full statistics about this can be seen in Table 22 attached below.

Table 22

Cross Tabulation Table for Perception of Evolution of Climate with Respect to Science Degree

Evolution	Science degree holders		No science degree holders	
	Mean	SD	Mean	SD
Human activity as main cause of global warming	1.40	0.84	1.46	0.76

Hypothesis 4

H4: Science knowledge, the general education level, holding a science degree, the mean perception of health-related innovations, and the knowledge that scientists have a clear understanding of Covid-19 treatment are predictors for a person's agreement on the use of a Covid-19 vaccine, even though all phases of the medical trials for this vaccine are far from conclusive.

Multiple regression analysis was conducted after checking for assumptions. The outcome variable (i.e., a person's agreement on the use of a Covid-19 vaccine, even though all phases of the medical trials for this vaccine are far from conclusive) is measured on a continuous scale. The predictor variables—science knowledge, general education level, mean perception of health-related innovations and knowledge that scientists have a clear understating of Covid-19 treatment Covid-19—are also all continuous variables, while holding a science degree or not is a categorical variable. Variables were first checked for multicollinearity using linear regression and collinearity diagnostics. For the final analysis, all variables were entered in the linear regression analysis all at the same time, and confidence interval was taken as 95 percent. Scatter plots indicated linearity between the outcome variable and the predictor variables of science knowledge, general education level, mean perception of health-related innovations, and knowledge that scientists have a clear understanding of how to treat Covid-19. Multicollinearity was checked by looking at the VIF values, and no collinearity was found. Missing variables were left out of the calculations, and answers of "Don't know" or refusal to answer were treated as missing variables.

Once all the assumptions were checked, a multiple regression was run to predict degrees of favorability towards use of the Covid-19 vaccine (even though all trials have not been completed) from the predictor variables: general education level, science knowledge, holding a science degree or not, mean perception of health-related innovations, and knowledge that scientists have a clear understanding of Covid-19 treatment. These variables, overall, predicted to a statistically significant degree favorability of using a Covid-19 vaccine whose clinical trials have not been completed, $F(5, 132) = 16.247$, $p < 0.001$, $R^2 = .383$. Indicatively, 38.3 percent of the variation in the use of Covid-19 Vaccine could be explained by variation in the predictor variables. Among these predictors, mean perception of health-related innovations was a significant predictor of Covid-19 vaccine use, with Beta= .698, t (136) =8.261, and p < 0.001. Related data is shown below in Table 23.

Table 23

Multiple Regression Predicting Perception of the Use of Covid-19 Vaccines even though the Medical Trials for This Vaccine are Far from Conclusive

						95% C.I for B	
	B	*S.E*	*Beta*	*t*	*Sig.*	*Lower*	*Upper*
Constant	.398	.754		.527	.599	-1.094	1.889
Holding a science	-.101	.189	-.039	-.534	.595	-.474	.273
Mean perception health	1.442	.175	.698	8.261	.000	1.096	1.787
Knowledge of scientists' clear understanding of Covid-19 treatment	-.157	.088	-.144	-1.780	.077	-.332	.018
Highest level of education completed	-.007	.076	-.007	-.092	.926	-.157	.143
Count of number science knowledg questions	-.164	.102	-.115	-1.612	.109	-.365	.925

The next section will look at additional correlations about SSI innovations.

Further Correlations about Perceptions of SSI Innovations

Table 24

Descriptive Statistics for Perception of Energy-Related Innovations—Fracking and Offshore Oil and Gas Drilling

Variable	*n*	*M*	*SD*
1. Fracking	162	1.72	.99
2. Offshore oil and gas drilling	162	1.75	.97
3. Use of experi-mental drugs	162	3.15	1.00
4. Safety of pesticides	162	2.17	1.08
5. Covid-19 as exagger-ation	162	4.07	1.05
6.Conserva-tism vs. Liberalism	161	3.66	1.02
7. Human activity as main cause of global warming	162	1.44	.76

$^{*}p < .05$, $^{**}p < .01$.

Table 24 above shows some descriptive statistics related to the perception of energy-related innovations and some other variables. Correlation analysis indicated a strong relationship between perception of fracking and offshore oil and gas drilling, $r = .790$, $p < .01$. Also, these findings indicated that both favoring of fracking and of offshore oil and gas drilling increased as allowing of experimental drugs increased ($r = .220$, $p < .01$ for fracking, and $r = .263$, $p < .01$ for offshore oil and gas drilling). Also, the belief in safety of pesticides increased ($r = .376$, $p < .01$ for fracking, and $r = .335$, $p < .01$ for offshore oil and gas drilling), and disbelief in human activity as the main cause of global warming increased ($r = .598$, $p < .01$ for fracking, and $r = .577$, $p < .01$ for offshore oil and gas drilling). Similarly, opposition to Covid-19 as an exaggeration of a cold decreased ($r =- .325$, $p < .01$ for fracking, and $r =- .338$, $p < .01$ for offshore oil and gas drilling), and being on the Liberal side of the Conservative-Liberal scale decreased ($r = -.541$, $p < .01$ for fracking, and $r = -.530$, $p < .01$ for offshore oil and gas drilling). These findings altogether point to a possible positive relationship between perception of fracking, off shore oil and gas drilling, support for experimental drugs, likelihood of not being liberal, possibility of Covid 19 as an exaggeration of a cold, believing in safety of pesticides and that human activity is not the main cause of global warming.

Table 25

Descriptive Statistics for Perception of Energy-Related Innovations—Nuclear Energy and Plant Fuel

Variable	*n*	*M*	*SD*
1. Nuclear energy	162	2.41	1.22
2. Bioengineered plant fuel	162	3.05	1.19
3. Safety of pesticides	162	2.17	1.08
4. Safety of genetically modified food	162	2.84	1.10

$^{*}p < .05$, $^{**}p < .01$.

Table 25 has some descriptive statistics for nuclear energy and bioengineered plant fuel energy. These findings indicated that as favoring of nuclear energy and bioengineered plant fuel increased, the perception of pesticides as safe increased, ($r = .342$, $p < .01$ for fracking, and $r = .182$, $p < .01$ for offshore oil and gas drilling), as did a similar perception that genetically modified food is safe ($r = .383$, $p < .01$ for fracking, and $r = .373$, $p < .01$ for offshore oil and gas drilling).

The analysis also indicates a positive medium significant relationship between the mean of increased use of innovative energy technologies and the mean of increased use of innovative health-related technologies, $r = .323$, $p < .01$, such that when energy-related innovations increased, health-related innovations also increased. With that, the following paragraphs will look at some of the extra health-related significant correlations.

Table 26

Descriptive Statistics for the Perception of Health-Related Innovations and Perceptions of Scientists' Understanding of Genetic modification

Variable	*n*	*M*	*SD*
1. Scientists knowledge about genetic modification	162	3.08	1.10
2. Artificial organs	162	3.85	.98
3. Bio-engineering viruses	162	2.86	1.11
4. Safety of pesticides	162	2.17	1.08
5. Safety of genetically modified food	162	2.84	1.10
6. Covid-19 as an exaggeration	162	4.07	1.05
7. Perception that scientists have clarity on Covid-19 treatment	162	3.15	1.07

Correlations about health-related items indicated the perception that scientists have clear knowledge about genetically modified food showed positive significant correlations with all health items except for use of animals and experimental drugs. The findings indicated that as the perception that scientists have a clear understanding of the health effects of genetically modified food increased, support of bioengineered artificial organs increased, $r = .209$, $p < .01$; support of bio engineered viruses increased, $r = .260$, $p < .01$; the perception that pesticides are safe increased, $r = .271$, $p < .01$; the perception that genetically modified food is safe increased, $r = .372$, $p < .01$; and that scientists have a clear understanding of the treatment of Covid-19 also increased, $r = .418$, $p < .01$, while seeing Covid-19 as an exaggeration of a cold decreased, $r = -.275$, $p < .01$.

Table 27

Descriptive Statistics for Perception Of Health-Related Innovations and Perception of Covid-19 Vaccination

Variable	*n*	*M*	*SD*
1. Perception of Covid-19 vaccine	162	3.35	1.15
2. Use of animals for research	162	2.65	1.14
3. Experimental use of drugs	162	3.15	1.00
4. Bioengineered artificial organs	162	3.85	.98

5. Bioengineered viruses	162	2.86	1.10
6. Perception of safety of genetically modified foods	162	3.08	1.10
7. Perception that scientists have clarity on Covid-19 treatment	162	3.15	1.07

Similarly, support for Covid-19 vaccination correlated positively and significantly with all health items. The results showed that as support for Covid-19 vaccination increased, support for the use of animals for research increased, $r = .256$, $p < .01$; support for experimental use of drugs increased, $r = .309$, $p < .01$; support for bioengineered artificial organs increased, $r = .259$, $p < .01$; support for bioengineered viruses increased, $r = .267$, $p < .01$; the perception that genetically modified food is safe increased, $r = .281$, $p < .01$; and lastly, the perception that scientists have a clear understanding of Covid-19 treatment also increased, $r = .230$, $p < .01$.

As for evolution of climate, knowledge about scientists' consensus that the Earth is getting warmer because of human activity had a medium positive significant relationship with Conservatives vs. Liberals, $r = .467$, $p < .01$; there was a significant medium negative correlation with the mean of energy-related technology, $r = -.401$, $p < .01$, meaning that as knowledge on scientists' consensus on human activity as the main cause of global warming increased, the tendency towards a Liberal political outlook also increased, while support for energy-related technology decreased.

Lastly, as age increased, education level also increased, $r = .213$, $p < .01$. Science knowledge also had a positive significant small relationship with the general level of education, $r = .253$, $p < .01$, such that as the education level increased, the number of correct answers to science knowledge questions also increased.

These findings may be helpful for future research to highlight other factors that affect perceptions of SSIs other than science knowledge, education level, and science degree, which are the focus of this research.

Chapter 4

Study 2

Study 2 is a secondary analysis of the 2014 Pew Research Center Dataset, using selected parts of the database, questionnaire and codebook. The dataset includes 2002 adults who are representative of the U.S. population. The goal of Study 2 is to investigate the relationship between the U.S. public's science knowledge, general education level, degree of keeping up with science news, and perceptions of socioscientific issues' related innovations. Socio scientific issues, SSIs are defined as controversial issues related to science (Zeidler & Keefer, 2003) that need a holistic understanding of the issue in connection to economics, ethics, morality, and politics. Example SSIs would be global warming, use of vaccines, genetic engineering of food, or animal. The dependent variable is comprised of two subcategories: perception of SSI-related innovations (energy and health). The independent variables are science knowledge, keeping up with science news, and general education level.

Unlike Study 1, the current research explores only the relationships between keeping up with science news, education level and science knowledge and perception of SSI-related innovations. It does not examine holding a degree or not, nor at Covid-19 pandemic-related questions. Further, Study 2 uses a larger sample: all states in the U.S. rather than only one small rural area. The current study considers all participants. However, only selected scales from the questionnaire are being used. Weighting variables as calculated by Pew researchers will be applied for all data analysis to better represent the population.

Hypotheses

Study 2 investigates the relationship between keeping up with science news, education level, science knowledge, and perception of SSI-related innovations. The research question is:

How does keeping up with science news, education level and science knowledge predict perception of SSI-related innovations with respect to energy and health? Independent variables are keeping up with science news, education level and scientific knowledge, while the dependent variable is perception of SSI-related innovations measured in the two subcategories of health and energy.

Method

Participants

As indicated in the codebook of the 2014 Pew Research Center Survey Dataset, a national sample of 2002 adults were contacted by telephone with 801 respondents being interviewed on a landline telephone and 1201 being interviewed on a cell phone. All adults were 18 years of age or older, living in all fifty U.S. states and the District of Colombia. In order to reach a representative sample of adults in the U.S., Pew researchers used a combination of landline and cell random digit dial (RDD) samples, and disproportionally stratified both of these samples to increase the incidence of Hispanic and African-American responses. "They also drew phone numbers with equal probabilities within each stratum. The landline samples were list-assisted and drawn from active blocks containing one or more residential listings, while the cell samples were not list-assisted but were drawn through a systematic sampling from dedicated wireless 100-blocks and shared service 100-blocks with no directory-listed landline numbers. The researchers disproportionately stratified both the landline and cell RDD samples by county based on estimated incidences of African-American and Hispanic respondents". If the participants did not know an answer to a question or refused to reply, it was generally coded with a code of 9, along with being coded as 99 for age, or 10 for income. All 2002 subjects' data that had answers other than “Don’t know” or “Refused to reply” were used.

Protection of Human Subjects

Study 2 has been reviewed by the Claremont Graduate University International Review Board and determined to be exempt (Appendix III). As indicated in the codebook of the 2014 Pew Research Center Survey Dataset, the confidentiality of participants has been protected. The Pew Research Center does not release participant names, contact numbers or any other uniquely identifying information. Pew researchers have also collapsed certain variables into categories before being released for added confidentiality.

Procedures

As indicated in the 2014 Pew Research Center survey codebook, all interviews were completed in English and Spanish by live, professionally trained interviewing staff under the direction of Princeton Survey Research Associates International from August 15 to August 25, 2014, using a Computer Assisted Telephone Interviewing (CATI) system. 2014 Pew Research Center codebook states that CATI ensures that questions are asked in the right order, and also that the questions that need to be randomized are rotated to eliminate the effect of sequencing. Further, the codebook indicates that for the landline sample, half of the time interviewers asked to speak with the youngest adult male currently at home, while asking for the youngest adult female the other half of the time. If the requested gender was not present, the opposite gender that was currently at home was asked to speak. For the cell phone interviews the interviewers spoke with the person who answered the phone after verifying the age and safety of the call. Interviewers made as many as seven attempts to contact every sampled telephone number while staggering the calls at varied times of day and days of the week (including at least one daytime call) to maximize the chances of making contact with a potential respondent (Pew, 2014).

Pew Research Center developed the survey and used consultation from senior staff of the American Association for the Advancement of Science (AAAS) and several outside advisers. First, Pew conducted a pilot study during August 5-6, 2014, with 101 adults living in the Continental U.S. They selected the landline sample from fresh RDD landline phone numbers (n=25) and a sample of cell phone numbers from a recent RDD omnibus studies databank of cell phone numbers. In order to better understand respondents' thoughts as they completed the survey, the researchers also included a few open-ended questions in the pilot study. As a final step, Pew researchers ran a pretest on Aug 12, 2014, of 24 adults living in the Continental U.S. The sample for the pretest was selected similarly to the first pilot study using fresh RDD landline phone numbers for the landline sample, and a sample of cell phone numbers from respondents interviewed in recent RDD omnibus studies. The final questionnaire was approximately 22 minutes long.

Weighting

Pew Researchers have used several stages of weighting to adjust data so that the sample is able to represent the larger population. The 2014 Pew Research Center Survey codebook indicated that several stages of statistical adjustment or weighting were used to account for the complex nature of the sample design. The weights account for numerous factors, including (1) the different, disproportionate probabilities of selection in each strata; (2) the overlap of the landline and cell RDD sample frames; and (3) differential non-response associated with sample demographics.

The codebook indicated that the first stage of the weighting normalizes differences initiating from number of adults in the household, each person's probability of answering the phone, and whether a cell phone could also reach them. After weighting raking was performed based on parameters from the U.S. Census 2012 American Community Survey data, population density data derived from 2010 Census Data, and telephone usage data from the July-December, 2013, National Health Interview Survey. Through raking Pew researchers have ensured that race/ethnicity, gender by age, gender by education, age by education, census region, race/ethnicity, population density and household telephone status (landline only, cell phone only, or both landline and cell phone) all matched population parameters.

Secondary Data Analysis

The data had already been checked for completeness and normality by Pew researchers who also applied some weighting adjustments to make sure data is representative of U.S. adults. This research is a secondary analysis of the original Pew data where only some questions of the 2014 Pew survey were included in the secondary analysis, and data of all subjects who gave answers "Don't know" or " Refused to reply" were treated as missing data. Original weighting variables determined by Pew researchers were used for all data analysis.

Instrumentation

Materials

As indicated in the codebook of 2014 Pew Research Center Survey Dataset, the survey has questions measuring science knowledge, general education level, holding a science degree or not, perception of SSI-related innovations, and views on scientists' consensus about certain SSIs as well as a demographics section.

Measures

The following paragraphs will explain the related questions and questions' scoring for each measure from the survey.

Science knowledge was measured through five multiple choice questions and one true-false question, all based on factual knowledge of a range of science topics such as antibiotics, lasers, nanotechnology, chemical reaction, red blood cells and names of gases as causes of climate warming. These questions are denoted as knosct and range from knosct 14-19 in the survey. An example question is, "Which of these is a major concern about the overuse of antibiotics?" The questions and also the answer choices for each question were presented in a randomized order to each subject, in order to minimize the bias effect that could result from the order the questions were asked or the order in which the answer choices were presented. If the subject did not reply, they were probed once indicating to make their best guess. If the participant indicated that he/she did not know the answer or if she/he refused to answer, then this was recorded consequently as a code of 8 and 9. Pew researchers created a variable, knosct_count that counted the correct answer given to each knosct question. A person who answered all knosct questions wrong got "0" points and one who answered all questions correctly got 6 points. The answer code for the above example question was given as 1 point if the answer chosen was, "It can lead to antibiotic-resistant bacteria (Correct)"; 2 if the answer chosen was, "Antibiotics are very expensive"; 3 if the answer chosen was, "People will become addicted to antibiotics"; 8 if the answer chosen was, " Don't know"; and 9 if the person refused to answer. It must be noted that there was no general rule about which answers were measured as 1 or 2, and that it varied with each question. More detailed information on the measuring of each science knowledge question can be found in the Study 2 code sheet attached (Appendix II).

General education level was assessed by one question asking about the highest degree of education obtained: "What is the highest level of school you have completed or the highest degree you have received?" This question is denoted as educ2 in the survey. A value between 1-8 was given for each answer; 8 being the highest for "Postgraduate or professional degree, including master's, doctorate, medical or law degree (e.g., MA, MS, PhD, MD, JD, graduate school), and 1 being the lowest level of education, "Less than high school (Grades 1-8 or no formal schooling)". A value of 9 was given to "Don't know" or refusal to answer.

Keeping up with science news was measured by one question, asking how much one enjoys keeping up with news about science. Values varied from 1 for "A lot", 2 for "Some", 3 for "Not much, 4 for "Not at all", and 9 for "Don't know", or refusal to answer.

Perception of SSI-related innovations was assessed with 10 questions subdivided to two subcategories, including ***perception of energy-related innovations*** and ***perception of health-related innovations***.

Perception of energy-related innovations was comprised of four questions asking whether the respondent favors/agrees or opposes/disagrees with energy-related innovations such as the use of nuclear energy, fracking, offshore drilling, and use of genetically modified plants for liquid fuel. These questions were Q24 (b, c, d, e). An example question was, "The increased use of genetically modified plants to create a liquid fuel replacement for gasoline." Answers were given a value of 1 if they indicated "agree", 2 if they indicated "disagree", and 9 if the person indicated they do not know or did not answer.

Perception of health-related innovations included six questions asking whether the respondent favors/agrees or opposes/disagrees with health-related innovations such as use of animals for research, experimental use of drugs before fully tested, biological engineering of artificial organs, genetically modified foods, genetic modification of fetuses for higher intelligence, safety of foods grown with pesticides, and safety of genetically modified food These questions were numbered Q24a, Q24f, Q27, Q33, Q35 and Q38. An example is, “Thinking about the use of biological engineering to create artificial organs for humans needing a transplant operation, would you say this is making appropriate use of medical advances OR is it taking medical advances too far?” Answers were given a value of 1 if they indicated “agree”, 2 if they indicated “disagree”, and 9 if the person indicated they do not know or did not answer.

Demographics included questions about age, sex, income, marital status, number of people living in a house, political affiliation, political view (Democratic vs. Republican), and political ideology (Liberal vs. Conservative), and race. The related variables are agerec for age, educ2 for education level, sexz for sex, income, marital for marital status, hh1 for number of people living in the house, party for political affiliation, partyln for having a Liberal or Conservative political view, ideo for political ideology, hisp for Hispanic origin, and racecmb for race.

Results

Descriptive Statistics

Participants

The mean age was 50.51 (*SD* = 18.5). Participants were distributed evenly by gender, with 49.5 percent participants identifying as female and 50.3 percent as male.

Table 28

Race Identification

	Percentage
White	69%
African-American	14%
Asian	3.7%
Mixed Race	4.0%
Other race	9.4%

Of the participants, 18.1 percent indicated an origin of Hispanic, Latino or Spanish origin, while 81.9 percent did not.

Only 334 participants (16.7 percent) gave valid answers regarding U.S. citizenship, with 52.7 percent of these indicating that they are U.S. citizens while 47.3 percent indicating that they were not.

In regards to political affiliation, the highest percentage of the participants indicated being Moderate (37.7 percent), followed by 29.8 percent as Conservative, 19.9 percent as Liberal, 6.6 percent as Very Conservative, and 6.5 percent as Very Liberal.

Average income was between $40,000 and $49,999 with a mode of $50,000 to $59,999. Lastly, 48.5 percent of the participants were from suburban areas, followed by 40.3 percent from urban areas and 11.2 percent from rural areas.

I will now report the descriptive statistics for main variables of interest: Science Knowledge, general educational level, and holding a science degree or not. Next, I have presented descriptive statistics for perceptions of SSI-related innovations in areas of energy, space, health and evolution.

Science knowledge amongst participants was moderate (*M* = 4.22, *SD* = 1.67, Mode = 6). Of the participants, 31.2 percent answered all questions correctly, while only 1.6 percent had none correct.

Table 29

Science Knowledge Percentages

	Percentage
None correct	1.6%
1 correct	6.4%
2 correct	10.2%
3 correct	13.8%
4 correct	17.4%
5 correct	19.3%
6 correct	31.2%
Total	100%

With regards to the types of questions, participants had slightly more correct answers to questions about health and global warming in comparison to questions about chemical reaction, nanotechnology and lasers.

Table 30

Percentage of People with Correct Answers for the Related Question

	Percentage
Red blood cells (Health)	77.8%
Antibiotics (Health)	74.9%
Global warming	72.3%
Nanotechnology	65.7%
Chemical reaction	65.4%
Lasers	65.3%

As for sex difference, participants who identified as male answered more questions correctly (M = 4.51, SD = 1.63, Median = 5.00) than those participants who identified as female (M = 3.92, SD = 1.66, Median = 4), t (1996) = 8.018, p <0.00.

Further, the mean score for science knowledge increased with increasing education level except for a slight decrease of the mean score in the highest educational degree of postgraduate degree holders.

Table 31

Science Knowledge in Relation to Education Level

	Mean	SD
Less than high school	2.11	1.25
High school incomplete	2.90	1.61
High school graduate	3.73	1.63

Some college and no degree	4.05	1.60
Two-year Associate's degree from a college or university	4.16	1.60
Four-year college or university	4.80	1.42
Some postgraduate or professional schooling and no degree	5.25	1.27
Postgraduate degree	5.12	1.26

Education level and science knowledge had a moderate significant positive correlation such that as education level increased, science knowledge also increased $r = .422$, $p < 0.01$.

Similarly, science degree holders ($M = 5.22$, $SD = 1.32$) had slightly more correct answers than those without degrees ($M = 4.81$, $SD = 1.36$), t (807) = 4.22, $p < 0.00$.

As for race, participants who identified as mixed race answered more questions correctly, while those who identified as African-American had the lowest number of correct answers overall.

Table 32

Science Knowledge in Relation to Race

	Mean	SD
Mixed race	4.60	1.52
White	4.48	1.58
Asians	4.33	1.61
Some other race	3.52	1.68
African-American	3.28	1.62

Similarly, those identifying as of Hispanic, Latino or Spanish origin had a lower mean of 3.54 ($SD = 1.70$) then white non-Hispanics ($M = 4.58$, $SD = 1.54$), and other non-Hispanics ($M =$

4.40, *SD* = 1.68). However, in line with previous race related findings, non-Hispanic African-Americans (*M* = 3.33, *SD* =1.60) scored lower than those who identify as of a Hispanic, Latino or Spanish origin.

There was also a significant moderate positive correlation between income level and science knowledge, $r = .405$, $p < 0.01$, such that as income level increased science knowledge also increased. Lastly, there was a small negative significant correlation with age and science knowledge, such that as age increased, science knowledge decreased, $r = -.159$, $p < 0.01$.

As for education level, participants overall had high education with about 40.9 percent having a four-year college degree or higher.

Table 33

Education Level

	Percentages
Less than high school	3.7%
High school incomplete	4.4%
High school graduate	26.9%
Some college and no degree	14.2%
Two-year Associate's degree from a college or university	10.0%
Four-year college or university	21.3%
Some postgraduate or professional schooling and no degree	1.6%
Postgraduate degree	17.9%

Females, and males had similar education levels with males comprising a higher percentage of the two highest level of education.

Table 34

Education in Relation to Gender

	Female	Male
Less than high school	51.4%	48.6%
High school incomplete	56.3%	43.7%
High school graduate	48.5%	51.5%
Some college and no degree	51%	49%
Two-year Associate's degree from a college or university	51.3%	48.7%
Four-year college or university	50.6%	49.4%
Some postgraduate or professional schooling and no degree	47.2%	52.8%
Postgraduate degree	46.9%	53.1%

Those who identified as having a Hispanic, Latino, or Spanish origin seemed to have lower levels of education.

Table 35

Education Level with Respect to Hispanic, Latino or Spanish Origin

	Hispanic, Latino or Spanish origin
Less than high school	15.4%
High school incomplete	8.4%
High school graduate	34%
Some college and no degree	13.2%
Two-year Associate's degree from a college or university	9%
Four-year college or university	11.5%
Some postgraduate or professional schooling and no degree	1.1%

Postgraduate degree	7.3%

As for race identification, generally a higher percentage of Asians, whites and mixed race comprised higher education levels, while higher percentage of African-Americans and other races constituted lower educational levels.

Table 36

Education and Race Identification

	Asians	Whites	Mixed Race	Blacks	Other Race
Less than high school	0%	2.6%	1.3%	2.1%	15.8%
High school incomplete	1.4%	3.5%	2.5%	6.6%	8.2%
High school graduate	11.3%	30%	29.5%	36.1%	34.4%
Some college and no degree	19.7%	13.7%	16.7%	14.2%	15.3%
Two-year Associate's degree from a college or university	4.2%	9.4%	14.1%	14.6%	8.2%
Four-year college or university	29.6%	22.8%	23.1%	17.2%	13.1%
Some postgraduate or professional schooling and no degree	2.8%	1.7%	3.8%	0.7%	0.5%
Postgraduate degree	31%	21.3%	9%	8.4%	4.4%

U.S. citizens generally held higher education degrees when compared to non-U.S. citizens. It must be noted, however that only 329 of 2002 participants gave a YES or NO answer to this question.

Table 37

Education Level and U.S. Citizenship

	U.S. citizen	Non-U.S. citizen
Less than high school	13.1%	86.9%
High school incomplete	2.9%	97.1%
High school graduate	17.1%	82.9%
Some college and no degree	63.2%	36.8%
Two-year Associate's degree from a college or university	68.8%	31.2%
Four-year college or university	61.5%	38.5%
Some postgraduate or professional schooling and no degree	100%	0%
Postgraduate degree	63%	37%

As for holding a science degree or not, only 40.4 percent of the participants answered this question, with the rest refusing to answer, indicating they do not know or were unwilling to state their area of study. Among participants who provided an answer, 37.1 percent indicated a science degree.

In terms of sex differentiation, there were slightly fewer females (48.7 percent) holding a science degree when compared to males (51.2 percent), t (807) = -2.14, p <0.05. Of the people who claimed a science degree, only 8.8 percent of participants indicated themselves as of Hispanic, Latino or Spanish origin.

In terms of race differentiation, Asians constituted the highest percentage of science degree holders at 62.2 percent, followed by some other race at 39.4 percent, whites at 36.8 percent, mixed race at 32.1 percent, and African-Americans at 28.2 percent.

Non- U.S. citizens constituted slightly larger group of science degree holders, with 52.1

percent of non-U.S. citizens and 47.9 percent of U.S. citizens.

As for political ideology differentiation, Very Conservative respondents had the highest percentage of science degree holders (43.75 percent) followed by Moderates at 40.1 percent, Liberals at 38 percent, conservatives at 34.6 percent and very Liberals at 25 percent. Lastly, 43.9 percent of rural people had science degrees followed by 36.7 percent urban and 36.5 percent of suburban.

Next, this report explores demographics as related to perceptions of SSI in four domains of energy, space, health and evolution.

Table 38

Perception of Energy-Related SSI Innovations

Energy-related variable	Percentage that favors
Nuclear energy	50.1%
Genetically modified plants	72.9%
Offshore oil and gas drilling	54.4%
Fracking	44.9%

In terms of perception of energy-related SSI-related innovations, participants overall indicated a perception that favors use of nuclear energy, use of genetically modified plants, and use of offshore oil and gas drilling in U.S. waters while opposing fracking.

Table 39

Perception of space-related SSI innovations

Space-related variables	Percentage that favors
The Space Station is a good investment	72.2%
Including human astronauts in place of only robot astronauts	62.2%

Table 40

Perception of Health-Related SSI Innovations

Health related variables	Percentage
Use of animals in research	51.6% favors
Access to experimental drugs before critical trials have shown drugs to be safe	56.8% favors
Use of biological engineering to create artificial organs for humans	78% favors
Changing baby genes to make them smarter	82.6% opposes
Checking to see if food products are genetically modified	31.3% never 17.2% not too often 26.1% sometimes 24.9% always
Safety of foods grown with pesticides	70.4% find it unsafe
Safety of genetically modified foods	58.3% find it unsafe
Scientists' understanding of the health effects of genetically modified crops	69.6% think scientists do not have a clear understanding

As for health-related perceptions, participants favored use of animals in research, allowing more people to have access to experimental drugs before critical trials have been completed, biological engineering to create artificial organs for humans regarding a transplant operation, while opposing changing fetal genes to make the baby more intelligent. As for safety of foods grown with pesticides or being genetically modified, participants found both to be unsafe, and agreed that scientists do not have a clear understating of the health effects of genetically modified crops.

Table 41

Perception of Evolution-Related SSI Innovations

Evolution related variables	Percentage that agrees
Humans evolved over time.	69%
Human evolution is a natural phenomenon.	60.1%
Scientists agree that humans evolved over time.	70.7%
Earth is getting warmer because of human activity such as burning fossil fuels.	53.2%
Earth is getting warmer because of natural patterns.	24.7%
There is no solid evidence that the Earth is getting warmer.	22.1%
Scientists agree that Earth is getting warmer due to human activity.	61.7%

Lastly for perceptions related to evolution of humans and climate change, participants thought humans evolved over time, and agreed that human evolution is a natural phenomenon in contrast to evolution being guided by a supreme being. Participants also agreed that scientists generally have a consensus that humans evolved over time. Regarding views about climate, most of the participants thought that Earth is getting warmer mostly because of human activity such as burning fossil fuels, while some thought it was due to natural patterns, or that there was no solid evidence that the Earth is getting warmer. In addition, most of the participants agreed that scientists have a consensus that the Earth is getting warmer due to human activity.

The next section will continue with Hypothesis Testing.

Hypothesis Testing

Due to the categorical nature of the dependent variables, binary logistic regression was used to examine whether keeping up with science news, education level, and science knowledge were associated with any perception of SSI-related innovations in the areas of energy and health. The independent variables were keeping up with science news, education level and science knowledge, while the dependent variable was the perception of SSI-related innovations in the subcategories of health and energy. Keeping up with science news was measured on a Likert scale,while education level and science knowledge were all ordinal. The dependent variable, perception of SSI-related innovations was dichotomous in nature with categories of favoring and opposing. Variables were first checked for multicollinearity using linear regression and multicollinearity. For the final analysis, all variables were entered in the binomial regression analysis at the same time, and CI for exp (B) was taken as 95 percent. Residuals were taken as outliers outside 2 SD. Missing variables were left out of the calculations, and answers of "Don't know" or refusal to answer were treated as missing variables by defining them as such in the variables. One main research question with two subcategories of energy and health was tested:

Research Question 1

Do keeping up with science news, education level and science knowledge predict perception of socio-scientific innovations in the areas of energy (fracking, nuclear, genetic plants and offshore oil and gas drilling), and health (animal use for research, use of experimental drugs, genetic modification of artificial organs, genetic modification to make a baby smarter, safety of pesticides, and safety of genetically modified food)?

H1a: Keeping up with science news, education level, and science knowledge predict perception of energy-related socio-scientific innovations in subcategories of fracking, nuclear, genetic plants and offshore oil and gas drilling.

H1b: Keeping up with science news, education level, and science knowledge predict perception of health-related socio-scientific issues in sub categories of use of animals for research, use of experimental drugs, genetic modification of artificial organs, genetic modification to make a baby smarter, safety of pesticides, and safety of genetically modified food.

Hypothesis Testing for Perceptions of Energy-Related Socio-Scientific Innovations

For testing perceptions of fracking, a preliminary analysis for fracking suggested that the assumptions of multicollinearity were met for reading news (tolerance = 0. 887), science knowledge (tolerance= 0. 791), education level (tolerance = 0. 794). An inspection of standardized residual values revealed that there were no outliers. Missing variables were left out of the calculation through listwise deletion. The model was statistically significant, χ^2 (3, *N*= 1799) = 10.96, $p < 0.05$, suggesting that it would distinguish between those participants favoring and not favoring fracking. The model explained between 0.6 percent (Cox & Snell R Square), and 0.8 percent (Nagelkerke R square) of the variance in the dependent variable and correctly classified 55.6 percent of the cases. As shown in Table 42, education level and keeping up with science news significantly contributed to the model, while science knowledge did not. However keeping up with science news was marginally significant. The education level odds ratio of 0.94 suggests that for every increase in education level, participants were less likely to favor fracking. The keeping up with science news odds ratio of 0.862 means that for every increase in frequency of keeping up with science news participants were less likely to oppose fracking. Science knowledge was not a significant predictor.

Table 42

Logistic Regression Predicting Perception of Fracking

	B	*S.E*	*Wald*	*df*	*Sig.*	*Exp(B)*	*95% C.I. for EXP(B)*	
							Lower	*Upper*
Q3. How much do you enjoy keeping up with science news?	-.148	.055	7.387	1	0.007	.862	.775	.960
EDUC2. What is the highest level of school you have completed?	- .062	.027	5.472	1	0.019	.940	.892	.990
Count of number of science Knowledge questions Answered	.015	.033	.197	1	.657	1.015	.951	1.082
Constant	.0723	.216	11.195	1	.001	2.061		

For testing perception of engineering of genetic plants as fuel source, checking for presumptions suggested that the assumptions of multicollinearity were met for reading news (tolerance = 0.884), science knowledge (tolerance= 0.786) and education level (tolerance = 0.793). An inspection of standardized residual values revealed that there were no outliers. Missing variables were left out of the calculation through listwise deletion. The model was statistically significant, χ^2 (3, N = 1866) = 11.66, $p < 0.01$, suggesting that it would distinguish between those favoring and not favoring engineering of genetic plants as fuel source. The model explained between 0.6 percent (Cox & Snell R Square), and 0.9 percent (Nagelkerke R square of the variance in the dependent variable and correctly classified 72.9 percent of the cases. As shown in Table 43, science knowledge and keeping up with science news significantly contributed to the model, while education level did not. The reading news odds ratio of 1.124 suggests that for one level of increase in frequency of keeping up with science news, the participants were 1.124 times more likely to favor production of genetically modified plants for fuel. The science knowledge odds ratio of 0.923 suggests that for one level of increase in science knowledge, the participants were less likely to favor production of genetically modified plants for fuel.

Table 43

Logistic Regression for Perception of Production of Genetically Modified Plants for Fuel

Variables	*B*	*S.E*	*Wald*	*df*	*Sig.*	*Exp (B)*	*95% C.I. for EXP(B)*	
							Lower	*Upper*
Q3. How much do you enjoy keeping up with science news?	.117	.058	4.027	1	.045	1.124	1 .003	1.260
EDUC2. What is the highest	.030	.029	1.070	1	0.301	1.031	.973	1.091

level of school you have completed?								
Count of number of science Knowledge questions Answered	- .080	.036	5.133	1	0.023	.923	.861	.989
Constant	-1 .019	.233	19.113	1	.000	.361		

Thirdly, for testing perception of building more nuclear plants, analysis indicated that the assumptions of multicollinearity were met for keeping up with science news (tolerance = 0.885), science knowledge (tolerance= 0.790) and education level (tolerance = 0.796). An inspection of standardized residual values revealed that there were no outliers. Missing variables were left out of the calculation through listwise deletion. The model was statistically significant, χ^2 (3, N = 1892) = 21.851, $p < 0.01$, suggesting that it would distinguish between those favoring and not favoring building of more nuclear plants. The model explained between 3.2 percent (Cox & Snell R Square), and 4.3 percent (Nagelkerke R square) of the variance in the dependent variable, and correctly classified 54.2 percent of the cases. As shown in Table 44, education level significantly contributed to the model, while keeping up with science news marginally significantly contributing, and scientific knowledge not being a significant contributor to the model. The reading news odds ratio of 1.106 suggests that for one level of increase in frequency of keeping up with science news, the participants were 1.106 times more likely to favor building of more nuclear plants. Similarly, the odds ratio of 0.906 indicated that for each level of increase in education level, participants were less likely to favor building of more nuclear plants.

Table 44

Logistic Regression for Perception of Building of More Nuclear Plants

Variables	*B*	*S.E*	*Wald*	*df*	*Sig.*	*Exp(B)*	*95% C.I. for EXP(B)*	
							Lower	*Upper*
Q3. How much do you enjoy keeping up with science news?	.101	.053	3.609	1	.057	1.106	.997	1.227
EDUC2. What is the highest level of school you have completed?	-.098	.026	14.447	1	.000	0.906	.861	.953
Count of number of science Knowledge questions Answered	.050	.032	2.460	1	.117	1.051	.988	1.118
Constant	.074	.208	.128	1	.720	1.077		

Lastly, for testing perception of offshore oil and gas, analysis indicated that the assumptions of multicollinearity were met for reading news (tolerance = 0.884), science knowledge (tolerance= 0.794) and education level (tolerance = 0.796). An inspection of standardized residual values revealed that there were no outliers. Missing variables were left out of the calculation through listwise deletion. The model was statistically significant, χ^2 (3, N = 1902) = 9.374, $p < 0.05$, suggesting that it would distinguish between those favoring and not favoring offshore oil and gas drilling. The model explained between 0.5 percent (Cox & Snell R Square), and 0.7 percent (Nagelkerke R square) of the variance in the dependent variable, and correctly classified 55.1 percent of the cases. As shown in Table 45, keeping up with science news and education level significantly contributed to the model, while science knowledge did not. The education odds ratio of 0.94 suggests that for every increase in the level of education, participants were less likely to favor offshore oil and gas drilling. On the other hand, the keeping up with science news odds ratio of 0.883 suggests that for one level of increase in frequency of keeping up with science news, the participants were less likely to oppose offshore oil and gas drilling.

Table 45

Logistic Regression for Perception of Offshore Oil and Gas Drilling

Variables	*B*	*S.E*	*Wald*	*df*	*Sig.*	*Exp(B)*	*95% C.I. for EXP(B)*	
							Lower	*Upper*
Q3. How much do you enjoy keeping up with science news?	-.124	.053	5.446	1	.020	0.883	.796	.980
EDUC2. What is the highest level of school you have completed?	- .059	.026	5.238	1	.022	.943	.896	.992
Count of number of science Knowledge questions Answered	-.006	.032	.041	1	.839	.994	.934	1.057
Constant	.380	.209	3.313	1	.069	1.463		

Hypothesis Testing for Perception of Health-Related Socio-Scientific Innovations

H1b: Keeping up with science news, education level, science knowledge predicts perception of health-related socio-scientific issues in six subcategories of use of animals for research, use of experimental drugs, genetic modification of artificial organs, genetic modification to make a baby smarter, safety of pesticides, and safety of genetically modified food.

For testing perception of use of animals for research, a preliminary analysis suggested that the assumptions of multicollinearity were met for reading news (tolerance = 0.881), science knowledge (tolerance= 0.787), education level (tolerance = 0.790). An inspection of standardized residual values revealed that there were no outliers. Missing variables were left out of the calculation through listwise deletion. The model was statistically significant, χ^2 (3, N = 1905) = 98.15, $p < 0.001$, suggesting that it would distinguish between those favoring and not favoring use of animals in research. The model explained between 5 percent (Cox & Snell R Square), and 6.7 percent (Nagelkerke R square) of the variance in the dependent variable, and correctly classified 59.1 percent of the cases. As shown in Table 46, education level, keeping up with science news and science knowledge all significantly contributed to the model. The education level odds ratio of 0.88 suggests that for every increase in education level, participants were less likely to favor use of animals in research. Similarly, the science knowledge odds ratio of 0.89 suggests that for every increase in the number of correct science knowledge answers, participants were less likely to favor use of animals in research. Also, the odds ratio of 1.170 for keeping up with science news indicates that for every unit of increase in keeping up with science news, participants were 1.170 times more likely to favor use of animals for research.

Table 46

Logistic Regression Predicting Perception of Use of Animals for Research

Variables	*B*	*S.E*	*Wald*	*df*	*Sig.*	*Exp(B)*	*95% C.I. for EXP(B)*

							Lower	*Upper*
Q3. How much do you enjoy keeping up with science news?	.157	.054	8.550	1	.003	1.170	1.053	1.300
EDUC2. What is the highest level of school you have completed?	- .134	.026	25.890	1	.00	.875	.831	.921
Count of number of science Knowledge questions Answered	- .121	.032	14.073	1	.00	.886	.832	1.300
Constant	.0796	.212	14 .088	1	.00	2.216		

For testing perception of use of experimental drugs, a preliminary analysis suggested that the assumptions of multicollinearity were met for reading news (tolerance = 0.885), science knowledge (tolerance= 0.784), education level (tolerance = 0.791). An inspection of standardized residual values revealed that there were no outliers. Missing variables were left out of the calculation through listwise deletion. The model was statistically significant, χ^2 (3, *N* = 1901) = 65.73, $p < 0.001$, suggesting that it would distinguish between those favoring and not favoring use of experimental drugs. The model explained between 3.4 percent (Cox & Snell R Square), and 4.6 percent (Nagelkerke R square) of the variance in the dependent variable, and correctly classified 59.8 percent of the cases. As shown in Table 47, education level, and science knowledge all significantly contributed to the model, while keeping up with science news was only marginally significant. The education level odds ratio of 0.95 suggests that for every increase in education level, participants were less likely to favor use of experimental drugs. Similarly, the science knowledge odds ratio of 0.85 suggests that for every increase in the number of correct science knowledge answers, participants were less likely to favor use of experimental drugs. Also, the odds ratio of 1.105 for keeping up with science news indicates that for every unit of increase in keeping up with science news, participants were 1.105 times more likely to favor use of experimental drugs.

Table 47

Logistic Regression Predicting Perception of Use of Experimental Drugs

Variables	*B*	*S.E*	*Wald*	*df*	*Sig.*	*Exp(B)*	*95 percent C.I. for EXP(B)*	
							Lower	*Upper*
Q3. How much do you enjoy keeping up with science news?	.100	.053	3.560	1	.059	1.105	.996	1.226
EDUC2. What is the highest level of school you have completed?	- .056	.026	4.462	1	.035	.946	.898	.996
Count of number of science Knowledge questions Answered	- .167	.032	27.129	1	.00	.847	.795	.901
Constant	.503	.209	5 .802	1	0.016	1.653		

For testing perception of genetically engineering of artificial organs, a preliminary analysis suggested that the assumptions of multicollinearity were met for reading news (tolerance = 0.884), science knowledge (tolerance= 0.783, education level (tolerance = 0.793). An inspection of standardized residual values revealed that there were no outliers. Missing variables were left out of the calculation through listwise deletion. The model was statistically significant,

χ^2 (3, *N*= 1908) = 148.457, p < 0.001, suggesting that it would distinguish between those favoring and not favoring genetically engineering of artificial organs. The model explained between 7.5 percent (Cox & Snell R Square), and 11.5 percent (Nagelkerke R square) of the variance in the dependent variable and correctly classified 78.4 percent of the cases. As shown in Table 48, keeping up with science news and science knowledge both significantly contributed to the model, while education level did not. The keeping up with science news odds ratio of 1.26 suggests that for every increase in frequency of reading news, participants were 1.26 times more likely to favor genetic modification of artificial organs. Similarly, the science knowledge odds ratio of 0.73 suggests that for every increase in the number of correct science knowledge answers, participants were less likely to favor genetic modification of artificial organs. Casewise residuals were kept as they were marginal.

Table 48

Logistic Regression Predicting Perception of Genetic Modification of Artificial Organs

Variables	*B*	*S.E*	*Wald*	*df*	*Sig.*	*Exp(B)*	*95% C.I. for EXP(B)*	
							Lower	*Upper*
Q3. How much do you enjoy keeping up with science news?	.229	.061	13.980	1	.00	1.257	1.115	1.418
EDUC2. What is the highest level of school you have completed?	- .048	.033	2.159	1	.142	.953	.893	1.016
Count of number of science Knowledge questions Answered	- .321	.038	71.916	1	.000	.725	.673	.781

Constant	-.235	.240	.957	1	0.328	.791	

For testing perception of genetic modification to make a baby, a preliminary analysis suggested that the assumptions of multicollinearity were met for reading news (tolerance = 0.883), science knowledge (tolerance= 0.793), education level (tolerance = 0.798). An inspection of standardized residual values revealed that there were no outliers. Missing variables were left out of the calculation through listwise deletion. The model was statistically significant, χ^2 (3, *N*= 1936) = 16.392, p < 0.001, suggesting that it would distinguish between those perceiving changing baby's genes to make them smarter as appropriate use of medical advances or not. The model explained between 0.8 percent (Cox & Snell R Square), and 1.5 percent (Nagelkerke R) square of the variance in the dependent variable and correctly classified 84.5 percent of the cases. As shown in Table 49, education level and keeping up with science news both significantly contributed to the model, while science knowledge did not. The education level odds ratio of 1.120 suggests that for every increase in education level, participants were 1.120 times more likely to perceive changing baby's genes to make them smarter as taking science too far. Keeping up with science news' odds ratio of 1.247, on the other hand, indicated that for every increase in frequency of keeping up with science news, participants were 1.247 times more likely to find changing baby's genes to make them smarter as an appropriate use of science. Casewise residuals were kept as they were marginal.

Table 49

Logistic Regression Predicting Perception of Changing Baby's Genes to Make Them Smarter

Variables	*B*	*S.E*	*Wald*	*df*	*Sig.*	*Exp(B)*	*95% C.I. for EXP(B)*

							Lower	*Upper*
Q3. How much do you enjoy keeping up with science news?	.220	.075	8.704	1	0.003	1.247	1.077	1.443
EDUC2. What is the highest level of school you have completed?	.114	.036	10.086	1	.001	1.120	1.044	1.202
Count of number of science Knowledge questions Answered	- .029	.043	.449	1	.503	.972	.893	1.057
Constant	.874	.277	9.971	1	.002	2.396		

For testing perception of safety of foods grown with pesticides, a preliminary analysis suggested that the assumptions of multicollinearity were met for reading news (tolerance = 0.883), science knowledge (tolerance= 0.788), education level (tolerance = 0.793). An inspection of standardized residual values revealed that there were no outliers. Missing variables were left out of the calculation through listwise deletion. The model was statistically significant, χ^2 (3, *N* = 1918) = 102.588, p < 0.001, suggesting that it would distinguish between those perceiving foods grown with pesticides as safe or not. The model explained between 5.2 percent (Cox & Snell R Square), and 7.4 percent (Nagelkerke R square) of the variance in the dependent variable and correctly classified 70.3 percent of the cases. As shown in Table 50, education level, and science knowledge significantly contributed to the model, while keeping up with science news did not. The education level odds ratio of 0.93 suggests that for every increase in education level participants were less likely to perceive foods grown with pesticides as safe. Similarly, the science knowledge odds ratio of 0.77 suggests that for every increase in the number of correct science knowledge answers, participants were less likely to perceive foods grown with pesticides as safe.

Table 50

Logistic Regression Predicting Perception of Safety of Foods Grown with Pesticides

Variables	*B*	*S.E*	*Wald*	*df*	*Sig.*	*Exp(B)*	*95% C.I. for EXP(B)*	
							Lower	*Upper*
Q3. How much do you enjoy keeping up with science news?	.065	.061	1.125	1	0.289	1.067	.946	1.203
EDUC2. What is the highest level of school you have completed?	- .075	0.028	7.039	1	0.008	.927	.877	.981
Count of number of science Knowledge questions Answered	- .265	.038	48.476	1	0.00	.767	.712	.826
Constant	2.294	.252	83.047	1	0.000	9.914		

For testing perception of safety of genetically modified foods, a preliminary analysis suggested that the assumptions of multicollinearity were met for reading news (tolerance = 0.881), science knowledge (tolerance= 0.789), education level (tolerance = 0.797). An inspection of standardized residual values revealed that there were no outliers. Missing variables were left out of the calculation through listwise deletion. The model was statistically significant, χ^2 (3, N = 1862) =150.81, p < 0.001, suggesting that it would distinguish between those favoring and not favoring fracking. The model explained between 7.8 percent (Cox & Snell R Square), and 10.5 percent (Nagelkerke R square) of the variance in the dependent variable and correctly classified 66.1 percent of the cases. As shown in Table 51, keeping up with science news, education level, and science knowledge all significantly contributed to the model. The education level odds ratio of 0.91 suggests that for every increase in education level participants were less likely to perceive genetically modified foods as safe. Similarly, the science knowledge odds ratio of 0.76 suggests that for every increase in the number of correct science knowledge answers, participants were less likely to perceive genetically grown foods as safe. Also, the odds ratio of 1.155 for keeping up with science news indicates that for every unit of increase in keeping up with science news, participants are 1.155 times more likely to perceive genetically modified foods as safe.

Table 51

Logistic Regression Predicting Perception of Safety of Genetically Modified Foods

Variables	*B*	*S.E*	*Wald*	*df*	*Sig.*	*Exp(B)*	*95% C.I. for EXP(B)*	
							Lower	*Upper*
Q3. How much do you enjoy keeping up with science news?	.144	.058	6.179	1	.013	1.155	1.031	1.293
EDUC2. What is the highest level of school you have completed?	- .091	.027	11.25	1	.001	.913	.866	.963
Count of number of science Knowledge questions	- .279	.035	62.181	1	.00	.757	.706	.811

Answered						
Constant	1.730	.232	55.567	1	.00	5.639

CHAPTER 5

Discussion

Study 1

Using results from an online survey taken by members of Nextdoor Keene and/or Jay News, the purpose of this study was to examine the relationship between science knowledge level, education level, holding a science degree or not, and perception of innovations in areas of energy, space, health and evolution in a small rural area. Further, this research looked at the current SSI of Covid-19. It investigated the relationship of favoring Covid-19 vaccination with education level, science knowledge level, holding a science degree or not, mean perception of energy-related innovations, mean perception of health-related innovations, and knowledge that scientists are clear on Covid-19 treatment. The rural area chosen, provided residents with strong connection to nature with 6 millions of Adirondack state land surrounding the area, but also comprised of a highly educated residential body.

The results showed that there was no significant relationship between science knowledge level and perceptions of energy-related innovations, except for fracking, i.e., favoring fracking decreased as science knowledge increased. This finding is in line with Boudet et al.'s (2014) research, which found that opposition to fracking is more common among those who are familiar with the subject, women, and people who identify as Democrats. Considering that our sample had high levels of science knowledge and high general education, it is likely that they are more familiar with the subject. Further, our sample was composed of a high number of females and people who identify as Democrats. However, it must be noted that Boudet et al.'s (2014) research was from a national sample, which is different from the rural area of the current research. On a different note, our findings contradicted Davis & Fisk's (2014) research which points that older people with higher education levels are more supportive of fracking, but in that research the participant group was found to be more Conservative. In that respect our findings may be pointing out that political affiliation is a stronger factor in determining favoring of fracking in comparison to general education level and age.

As for health-related innovations, there were no significant correlations between science knowledge and health-related innovations except for the safety of eating genetically modified food. Findings indicated that as science knowledge increased, agreement on the safety of eating genetically modified food also increased. This finding adds to the research which shows that the relationship between scientific knowledge and belief in the genetically modified food varies. Some findings indicate that those who have higher levels of knowledge have less acceptance of genetically modified foods (Huffman et al., 2007; McCluskey et al., 2003; Vecchione et al., 2015), while others find that acceptance of genetically modified food increases as science knowledge increases (McComas et al., 2014; Mielby et al., 2012). Differences in measures of science knowledge could be one of the explanations for the difference in these findings.

As for the education level, analysis found no significant relationship between education level, and increased use of energy-related or space-related scientific innovations. Similarly, no significant relationship was found between the increased use of health-related innovations and the level of general education. However, correlation analysis indicated that education level had a small positive significant relationship with the use of animals in research, such that when education level increased, support for animal use in research also increased. This finding is in line with a 2014 Pew Research survey that had a large sample representing almost all of the U.S., which found that those with a postgraduate degree are more likely to accept use of animals for research than those with high school degrees only. Our finding adds to the 2014 Pew research to demonstrate that this relationship is also true in a small rural area. In the same category of health, disagreement with the belief that Covid-19 could be an exaggeration of a new intense cold significantly increased as education level increased. This is in line with the finding from Nagler et al. (2020) that indicated higher education degree holders agreed with medical experts about Covid-19. However, it must be noted that the same research also found that higher education degree holders disagreed with government-shared information about Covid-19 (Nagler et al., 2020).

As for science degree, t test analysis indicated no significant differences between groups of science degree versus no science degree holders in relation to energy- and space-related scientific innovations. For health, the t test analysis showed that science degree holders had statistically different results when compared to no science degree holders about using animals, genetic alteration of viruses, safety of pesticides, and trust in scientists' knowledge of genetically modified food. Saba and Messina (2003) found that as risk perception of pesticides decreased and benefit perception of pesticides increased, the inclination for eating food with pesticides also increased. It is possible that getting a science degree enabled holders to be more aware of the benefits associated with pesticides, compared to people with no science degree holders. Similarly, with respect to use of animals for research, Baldwin (1993) and Paul (1995) indicated that scientists are more likely to base their arguments on the benefits of animal research and lack of other options. There were no significant results found for the rest of the health items.

For Covid-19 vaccination, multiple regression analysis indicated a significant relationship between favoring Covid-19 vaccinations and predictors of science knowledge, education level, science degree, belief in scientists' knowledge on Covid-19 treatment, the mean perception of energy-related innovations, and the mean perception of health-related innovations; with the mean perception of health-related innovations as the only significant predictor. These findings are in accordance with Viswanath et al. (2021) which found that those with the least schooling were less likely to receive a Covid-19 vaccination for themselves or people in their care. The same study also found that those who had low confidence in scientists are least likely to vaccinate self or children. However, it must be noted that Visnawath et al. (2021) indicated that those participants who had an education level less than high school had a likelihood of Covid-19 vaccination similar to those of some college degree or bachelor degree holders, so the relationship between education level and getting a Covid-19 vaccine must be considered carefully.

Another study done in a rural college town in the U.S. (Lennon, 2021) indicated that distrust in the system of the evaluation of the Covid-19 vaccine was the primary cause of vaccine hesitancy, and that this hesitancy did not stem from negative vaccine beliefs. To our knowledge this dissertation is the first study looking at perceptions towards SSIs in a small rural area, and the only one looking at rural support or opposition of Covid-19 vaccinations especially during the early stages of Covid pandemic. These findings extend the literature to better understand public perception of SSI-related science innovations.

While the conclusions drawn from this study are informative, I have identified several limitations to be addressed in the subsequent section.

First, this survey was carried out when Covid-19 mask mandates were strongly in order with Covid-19 vaccinations still in test phase and not available for public use. It was also holiday season during which the psychology of people may have partially been affected by an uplifted hopeful mood, and hence this might have affected their reports. Secondly, our sample size was on the smaller end, and consisted of participants from Nextdoor Keene and Jay News. Given the survey's online nature, the survey likely did not include participants who do not like using social media or online platforms, as well as those who do use online platforms but prefer not to take online surveys. Also, the word socio scientific issues used in the survey title might have been too abstract or estranging for some participants therefore skewing the data to only scientifically literate. The participants were highly educated, had higher income levels, were older, and declared themselves as mostly white. Hence, the high scores on the science knowledge should be taken with these demographics in consideration. Further, the survey was online with no extra monitoring to see if the participants got extra help through web searches, friends or family while answering questions. It must also be pointed out that these are small towns, and people might be sensitive about being seen as knowledgeable.

Another limitation was that SSIs are context based, and depend on many factors such as some being rooted in religious view, relation to finances or political views. Also, some of the questions about SSIs may not be super clear. For example when a participant answers a question about baby gene modification for smartness, they may be thinking of a baby with a potential mental sickness that may be prevented by such SSI innovation.

The fifth limitation is that this survey was administered through Nextdoor Keene and Jay News. Further comparisons of the demographics drawn from our survey and 2019 Census data constitute a limitation such that our survey sample displayed a slightly different demographic picture from the one depicted by 2019 Census data. Although a one-to-one comparison is not possible, it is important to note that the participants who were interested in taking the survey were a little different than those in the 2019 Census, in that participants in our survey were slightly older, included a higher female ratio, had a smaller percentage of lower income earners, did not include as many lower education degree holders, but did include a higher percentage of highest education levels. This is likely a result of the process of social data collection through Nextdoor Keene and Jay News, which possibly attracts only certain demographics. These discrepancies between our demographics and the 2019 Census data is a limitation that must be considered when generalizing our results for the whole rural area of Keene, Keene Valley, and Jay. However, these discrepancies between the Census and our demographics are also a finding for other researchers, as they show how social platforms like Nextdoor Keene and Jay News do not reflect the true demographics.

Studies with larger, more truly representative samples from rural areas would give us a better picture of perception of rural areas with regards to perception of socio-scientific innovations. This research was not able to find a significant relationship between science knowledge level, education level, and science degree in regards to perception of most of the SSIs. Hence it would be helpful to compare this research with, more representative samples to see if these findings are generalizable, or if they are a consequence of the unique sample from this rural area limited by online platform sampling. Further, it is highly likely that each rural area may have its own unique qualities that alter their perspectives with respect to SSIs. In any case, such research would be enriching and informative for our understanding and impact of rural area resident perceptions.

In the next section we will look at a very large data sample from the U.S. by using a secondary analysis of 2014 Pew research.

Study 2

Study 2 is a secondary analysis of the 2014 Pew Research Center dataset, using selected parts of the database, questionnaire, and codebook. The dataset includes 2002 adults who are representative of the U.S. population. The goal of Study 2 is to investigate the relationship between U.S. public's science knowledge, general education level, keeping up with science news, and the perception of SSI-related innovations in areas of energy and health.

My results indicated that as participants' frequency of keeping up with science news increased, participants were more likely to favor all SSI-related innovations in the realms of energy and health, except for fracking, offshore oil and gas drilling, and the use of pesticides. In fact, the odds that participants would oppose fracking and offshore oil and gas drilling increased as the frequency of keeping up with science news increased, while the use of pesticides just yielded insignificant results.

With respect to science knowledge, my findings indicated a contrary relationship to keeping up with science news in the realm of perception of health-related SSIs. As science knowledge levels increased, the odds of participants supporting health-related socio-scientific innovations decreased, except in the case of baby genes. Baby genes did not yield statistically significant results. In contrast, science knowledge did not predict perception of all energy-related socio-scientific innovations except for the use of genetically modified plants for fuel. As science knowledge increased, the odds of favoring genetically modified food also dereased.

Lastly, with regards to general level of education, my analysis indicated that as participants' general education level increased, participants were less likely to hold a favorable perception of all SSI-related innovations, except for the perception of modification of baby genes to make them smarter, the use of artificial organs, or the use of genetically modified plants for fuel. In fact, as education level increased, the odds of opposing the modification of baby genes to make them smarter also increased. As for the use of genetically modified plants to make fuel, and the use of artificial organs, the analysis did not yield significant results.

The sections below will go in depth to discuss these findings.

Keeping up with Science News

In Study 2, one of my findings was that as participants' frequency of keeping up with science news increased, the odds of them favoring energy or health-related innovations was significantly higher, except for the SSIs of fracking and offshore oil and gas drilling, where participants were more likely to oppose, and the use of pesticides, which was insignificant. Even though keeping up with science news has a great potential to inform the public of current SSIs, science news has faced a lot of criticism for not being peer reviewed, and possibly including bias, misrepresentations, or false evidence (McClune & Jarman, 2012). Science news is also usually written by non-scientists, and is often based on journalism motivations of sensationalism, profit, and manipulation (Jarman & McClune, 2007). Hence, a reader informed by science news is at the mercy of their own critical thinking skills in order to discern true information from false. Given my finding that a higher frequency of keeping up with science news were more likely to favor almost all SSI-related innovations, which also means lacking criticism, one may question the general critical thinking skills of participants.

Research by Lin (2014) has indicated that science-major students are significantly better at argumentation of science news displaying critical thinking skills, providing supporting evidence, arguments, and counter arguments for their claims. Supporting Lin's finding, participants of Study 2 had a very low percentage of science degree holders, which might also explain the high levels of favoring perception (lacking criticism).

Further, my second finding that the participants who opposed fracking, could also highlight this premise of lacking critical thinking skills, especially given the anti-fracking content of the science news at the time when survey data was collected. The documentary release of Gas Land, an anti-fracking documentary on HBO, was in 2010 and February 2011. After its release on Internet and YouTube, searches for fracking increased dramatically, while general media coverage of fracking also increased between 2010 and 2013 (Vasi et al., 2015). Since Pew data for Study 2 was collected in 2014, this means that our participants were highly imbued in an anti-fracking media environment. When we add to this possibility of undeveloped critical thinking skills while watching or reading science news, we may get an understanding of the increase in odds of opposition to fracking and offshore oil and gas drilling. Similar to fracking news coverage, an anti-offshore oil and gas drilling agenda was covered extensively in the news after the 2010 Deepwater Horizon accident. Again, considering the timing of the survey in 2014, participants may have bought into this anti-drilling story line of science news without much application of critical thinking. Nevertheless, it is also possible that participants were able to apply critical thinking and still oppose fracking. In any case, when considering the overall results of the survey, we could interpret it as participants seemingly just agreeing with and reiterating what they had been told by science news.

Progressing from Lin's findings (2014) about science degree and argumentation skills on SSI-related issues, the next section will investigate the relationship of science knowledge and its relationship to perception of SSI-related innovations.

Science Knowledge

Contrary to the findings about keeping up with science news, my findings indicated that as science knowledge increased, the odds of participants' favoring health-related socio-scientific innovations decreased. My findings support some research (Sadler & Fowler, 2006; Braten et al., 2011; Schalkl et al., 2013) that have indicated that students with more science knowledge on the topic of an SSI performed better in their argumentation of their claim using critical skills. However, when reviewing all these findings one needs to consider that they differed on how and when science knowledge was measured.

It must be noted that Pew survey questions about science knowledge were comprised of only six items, which were not based on SSI-related innovations. In the case of the abovementioned relatively recent research (Sadler & Fowler, 2006; Braten et al., 2011; Schalkl et al., 2013), participants were usually high school or college students who had directly or indirectly studied an SSI as part of a class while in school, and their answers usually were more in the form of longer explanations. In the case of my research, science knowledge questions were multiple choice, and consisted of only six, not necessarily even tapping into all the related SSI concepts of which participants' perception was measured.

Secondly, the timing of measuring SSI-related argumentative skills also differed between my research and other related research (Sadler & Fowler, 2006; Braten et al., 2011; Schalkl et al., 2013), which include data collected from students while they are still in school; Pew Research data was collected many years after participants had graduated from school. Recent retention studies on science knowledge (Custers et al., 2011) have indicated a significant decrease on the amount of retention after two years, hence it is not surprising to expect respondents to lack a scientific base to be able to form counterarguments.

Further, school curricula and instruction differ for relatively older and younger participant groups. Study 2 was based on 2014 Pew dataset that included relatively older adults, while more recent studies focus on university or high school students. Science curricula in schools have shifted in time to include a more current SSI-based approach, earning a lot of support from researchers (Krathwohl & Anderson, 2001; Lewis, 2003; Herreid, 2005; Sadler 2002; Hazen 2005; Tanner, 2009; Sadler & Zeidler, 2004).

Overall, the conclusion that may be drawn is this: Having more general science knowledge as opposed to specific scientific knowledge about the SSI under discussion, may be key in people having critical thinking and argumentative skills about the SSI.

Lastly, unlike findings about keeping up with science news, my study found no predictive relationship between science knowledge and energy-related innovations, except for plant fuel. This could be possibly stemming from the statistical analysis method used, which yielded a relatively weak effect even for significant output. Also, my study's science knowledge questions did not include any questions measuring science knowledge related to energy production even in a general sense.

The next section will consider the relationship of education level to perception of SSI-related innovations.

Education Level

My findings indicated that as education level increased, the odds that a participant would hold a favoring perception of energy and health-related SSI innovations decreased , except for the use of genetically modified plants for fuel, use of artificial organs, and modification of baby's genes to make them smarter. In fact, participants with a higher degree of education were more likely to oppose modification of baby genes to make them smarter.

Even though this overall decrease in favoring of SSI-related innovations could be interpreted as a general opposition to innovations, it must be noted that the mean of education level was more like an Associate's degree level, which makes it less likely that the participants were highly informed in innovative technology and/or science. Indeed, it raises the question of possibly undeveloped critical thinking skills in general.

It is interesting that as the education level increased, the items that yielded no significant relationship or even opposition were the ones that are relatively more recent innovations especially when the timing of the PEW survey was considered. News about baby genes editing for the purposes of making them smarter, for example is still a new concept, and not part of a mainstream science or education curriculum.

Overall, Study 2 was comprised of a racially- and sexually-homogenous representative sample of the U.S. from 2014. It must be noted that the strength of the significant relationships found in this study were weak. Further research with surveys that includes more and up-to-date science knowledge questions designed particularly to measure perception of innovations could give clearer information about the relationship between science knowledge and the perception of scientific innovations. Also, designing a new, again large and homogenously weighted study, where the perception of innovations is measured on a Likert scale rather than on a dichotomous scale as in Study 2, would likely increase statistical strength. Most importantly, some open-ended questions enabling qualitative analysis would help researchers understand public perceptions of SSI-related innovations. Also, SSIs are context based, and depend on many factors and also may not be clearly understood clearly. It would be good to collect data in such a way where such confusions are checked for.

Lastly, as we tumble through the current SSI of the Covid-19 pandemic, it would be even more interesting to understand how public's awareness, and thus their perception of general SSIs, is shifting as new information unfolds. So there is a dire need to be prepared by engaging in new, comprehensive research regarding public perception of SSIs in order to shape the future.

Study 1 and Study 2

As discussed in the above section, the strength of Study 2 is that it is based on a large sample that has been statistically weighted to create a race and gender-homogenous sample representative of the U.S. public in 2014; it could nevertheless be improved by using Likert scales rather than dichotomous scales, and include more, up-to-date and SSI-related science knowledge questions. Study 1, on the other hand was based essentially on Likert scales, and also able to include a more current SSI, namely Covid-19-related questions. However, Study 1 consisted of a relatively smaller, mostly white, very educated and financially more stable, self-select participants from a rural area in NY state. Both research studies measured science knowledge and education level with the same questions. Both studies looked at science knowledge and education level as influential variables, while Study 2 was also interested in keeping up with science news, and Study 1 on science degree as one of the independent variables, and perception of Covid related innovations (vaccinations and cure) as the dependent variables.

Considering the overlapping variables of education level and science knowledge, the comparable and contradicting findings of each study is interesting to look at.

As for relationship of science knowledge and perception of energy and health-related SSI innovations, there were no similar findings, but many significant findings from Study 2 while insignificant ones from Study 1.

On the contradictory end, as science knowledge increased, in Study 1, participants' perception of GMO food as safe also increased, while in Study 2, the odds of perceiving it as safe decreased.

Similarly, for relationship of education level, and perception of energy and health-related SSI innovations, there are no similarities between two studies, but Study 1 has manyinsignificant results, while Study 2 has many significant results. It is important to highlight again that science knowledge and education level in the Study 1 sample were very high, while they were only moderate in Study 2.

On the contradictory end, the two findings are about perception of use of animals for scientific research and safety of GMO food. In Study 1 as education level increased, support for use of animals for research, and agreement that GMO food is safe increased while the odds of supporting these SSIs decreased for Study 2.

This relationship between Study 1 and Study 2 brings up interesting questions regarding the effects of sample size, a rural area, participants and scale choices. Study 2, with a larger sample size, seems to yield a more significant number of significant predictions, while Study 1 yields insignificant correlations. One could ask whether this is resulting from the larger homogenized sample of Study 2, or how much of this effect is a result of rural area affect. This trend of higher number of significant findings for Study 2 continues with regards to the independent variable of keeping up with science news. And, again, for Study 1, we find a smaller number of significant correlations for the independent variable of science degree. These are all supportive of the idea that the large sample size of Study 2 and the relatively smaller sample size of Study 1 is important in making final conclusions of the findings of this research.

On the other hand, while one cannot compare the strength of correlation with the strength of predictability, the stronger correlations of Study 1 and the weaker predictabilities of Study 2 could be supportive of the idea that the Likert-based scales of Study 1 could indeed be yielding statistically more robust findings when compared to the dichotomous-based scales of Study 2. In addition, the high levels of education and science knowledge of Study1 sample may have led to the insignificant findings.

CHAPTER 6

Conclusion

Overall, looking at both Study 1 and Study 2 and the restrictions posed by each, it is hard to arrive at a general definitive finding about perception of SSIs. Yet, there are some important inferences that can be drawn from looking at both studies.

First of all, each SSI seems to be unique in how it is perceived. It seems better to treat perception of each SSI separately rather than looking for an overall perception of SSIs. As our findings indicated, some SSIs were supported by both studies (genetic engineered plants for fuel, , use of experimental drugs, and genetically engineered artificial organs), while others differed between the two samples (off-shore oil, nuclear, animals for research, virus modification). And, there were some SSIs that were opposed by both groups (fracking, baby gene modification, view that foods grown with pesticides or GMO food is safe).

However, it does seem like a higher education level seems to have the potential to lead to more critical thinking and consequently a less favorable perception of SSIs. In Study 2, the odds of supporting nuclear plants, off-shore oil and gas, use of animals in research and experimental drugs, decreased when the education level increased, while the group as a whole supported these

SSIs. And, the SSIs opposed by the overall participants in Study 2, still stayed as an opposition even when the education level increased. However, in Study 1, participants with higher education level favored use of animals for research, and agreed with the idea that GMO food is safe while the whole group opposed it. However, these relationships were weak.

In line with education level, in Study 2 higher levels of science knowledge seemed to yield a shift towards opposition of SSIs (plants for fuel, use of animals for research, experimental drugs and artifical organs) while the whole group had favored these SSIs. Also, the odds of agreement on the safety of GMO food and foods grown with pesticides decreased as science knowledge increased. Similarly, in Study 1, opposition to fracking increased as science knowledge increased. However, Study 1 yielded that as science knowledge increased, perception of GMO or food grown with pesticides as safe also increased. Further, this trend intensified with science degree holders supporting more nuclear energy, use of animals for research, virus modification while overall group opposed it, and perceived GMO as safe while overall group holding the thought of it as unsafe. Indeed, holding a science degree seemed to create the most number of shifts towards favorable perception of SSIs when compared with education level and science knowledge for Study 1.

Overall, this points to how advanced level of science education tailored towards a science degree is growing in a direction of more support for SSIs as opposed to such science education of a decade ago, and also as opposed to more basic level science education included in general education.

Keeping up with science news, also, did not seem to indicate a clear direction towards support or opposition of SSIs. Participants who kept up well with science news seemed to have a higher likelihood of opposing off-shore oil and fracking, but also a higher likelihood of supporting use of animals for research, and perceiving GMO food as safe. Further, they thought of changing baby genes to make them smarter as appropriate. This was very interesting as this was the only place where support for baby genes modification was found in both Study 1 and 2. Also, it was very interesting that keeping up with science news contradicted outcomes about education level in the SSIs of fracking and off-shore oil drilling. A higher education level does seem to enable participants to form more independent perceptions based on their cumulative knowledge or decision making, rather than what they were told. Similarly, in the case of modification of baby genes, participants with higher education opposed it, even though participants who had kept up with science news frequently indicated that genetic modification of baby genes was appropriate. It seems participants were uncomfortable with this idea based on their cumulative education. These findings point to how overall science news exposure is highly influential in creating a perception of an SSI.

Lastly, based on Study 1 outcomes, we can infer that being in a rural area with the possibility of a strong connection to nature seemed to decrease support for some SSIs, such as fracking, off-shore oil, nuclear and use of animals for research. This seems to point to how our personal experiences could have an effect on shaping our perception of SSIs. Considering our rural sample was highly educated, which possibly skewed results toward support of SSIs, it is very interesting that Study 1 could still yield opposition to those four SSIs. It is possible that this opposition could have been even bigger in rural areas with strong nature connection, but less education level.

Implications

Although it was not the main goal of this research, finding of Study 1 about how a small rural area can be so highly educated, also points to further research on the unique qualities of each rural area. Further, it brings up the question of how strongly opinions of rural areas are included in general research and policies. Rural areas may be able to teach us more about how deep connection to nature relates to perception of SSIs, which may also help us develop a broadened understanding of human experience that is not only abstract or theoretical.

Given influence of general education and basic science knowledge in shifting perceptions of SSIs toward opposition, while advanced levels of science education shifting perceptions of some SSIs toward support, it is even more important that we researchers have a clear understanding of how critical thinking and science knowledge related to SSIs play hand in hand. A science curriculum that is able to encompass a broader view of human experience that addresses critical thinking, science knowledge but also possible wisdom arising from deeper connection to nature may be a necessity for citizens to make better decisions on SSIs.

Most urgent, however is our need to develop awareness of our collective vulnerability to science news. We need to be mindful of how science news have a powerful effect on our perceptions. We may need to adjust our policies regarding how science news are produced and shared.

Lastly, as each person is the final decision maker with what they have been presented, it is very important that we develop our education system to include very strong critical thinking skills, such that each citizen can arrive at decisions not by what they were told through news or education, but through their own observations, insights and discernment. We need to set our policies with this awareness in mind if we want to evolve as a more conscious society.

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Appendix I. Questionnaire tool for study 1

U.S. citizens public perception of Socio-scientific issues

Survey Flow

Standard: - Openness to scientific and technological innovations (8 Questions)
Standard: -Belief in the existence for SSIs (7 Questions)
Standard: - Perception of scientists' consensus on SSIs (4 Questions)
Block: Science Knowledge Questions (6 Questions)

Branch: New Branch
If
If All in all do you favor or oppose .... Is Displayed

EmbeddedData
block2progress = made it!

BlockRandomizer: 2 -

EmbeddedData
random = 1
EmbeddedData
random = 2

Standard: Demographics (Base/Universal) (6 Questions)
Standard: Demographics (Extended) (2 Questions)
Standard: Demographics (Employment) (1 Question)
Standard: Demographics (Political) (3 Questions)

Page Break

Start of Block: - Openness to scientific and technological innovations

Q0 Please do NOT respond to this survey unless you are at least 18 years old and are a US citizen,or a legal U.S. resident.

Page Break

Q1 All in all do you favor or oppose ....

	Strongly Favor (5)	Favor (4)	Neutral (3)	Oppose (2)	Strongly oppose (1)
The use of animals in scientific research ()	○	○	○	○	○
Building more nuclear power plants to generate electricity ()	○	○	○	○	○
The increased use of fracking, a drilling method that uses high-pressure water and chemicals to extract oil and natural gas from underground rock formations ()	○	○	○	○	○
The increased use of genetically engineered plants to create a liquid fuel replacement for gasoline ()	○	○	○	○	○
Allowing more offshore oil and gas drilling in	○	○	○	○	○

U.S. waters ()					
Allowing more people access to experimental drugs before clinical trials have shown the drugs to be safe and effective for that disease or condition ()	○	○	○	○	○
Use of a newly developed Covid Vaccine eventhough all phases of the medical trials are far from conclusive ()	○	○	○	○	○

Q2 Thinking about the use of biological engineering to create artificial organs for humans needing a transplant operation, would you agree that this is a good investment ?

○ Strongly Agree (5)

○ Agree (4)

○ Neutral (3)

○ Disagree (2)

○ Strongly Disagree (1)

Page Break

X→

Q3 Do you think the SPACE STATION has been a good investment for this country?

- ○ Strongly Agree (5)
- ○ Agree (4)
- ○ Neutral (3)
- ○ Disagree (2)
- ○ Strongly Disagree (1)

Page Break

Q4 The cost of sending human astronauts to space is considerably greater than the cost of using robotic machines for space exploration. As you think about the future of the U.S. space program, do you think it is essential to include the use of human astronauts in space?

- Strongly Agree (5)
- Agree (4)
- Neutral (3)
- Disagree (2)
- Strongly Disagree (1)

Q5 Would you say that changing a baby's genetic characteristics to make the baby more intelligent is taking medical advances too far?

- Strongly Agree (5)
- Agree (4)
- Neutral (3)
- Disagree (2)
- Strongly Disagree (1)

Q6 When you are food shopping, how often, if ever, do you LOOK TO SEE if the products are genetically modified?

- ○ Always (5)
- ○ Often (4)
- ○ Not too often (2)
- ○ Never (1)
- ○ Don't know (9)

Q7 Would you say that using genetic engineering to alter genetic makeup of existing viruses, and also to create new viruses is making appropriate use of medical advances ?

- ○ Strongly Agree (5)
- ○ Agree (4)
- ○ Neutral (3)
- ○ Disagree (2)
- ○ Strongly Disagree (1)

End of Block: - Openness to scientific and technological innovations

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Start of Block: -Belief in the existence for SSIs

Q8 Which comes closer to your view?

- ○ Humans and other living things have evolved over time (5)
- ○ Humans and other living things have existed in their present form since the beginning of time (1)
- ○ Don't know (9)

Page Break

Display This Question:

If Which comes closer to your view? = Humans and other living things have evolved over time

Q8a And do you think that..

- Humans and other living things have evolved due to natural processes such as natural selection (5)
- A supreme being guided the evolution of living things for the purpose of creating humans and other life in the form it exists today (1)
- Don't know (9)

Q9 Which of these three statements about the earth's temperature comes closest to your view?

- The earth is getting warmer mostly because of natural patterns in the earth's environment (5)
- The earth is getting warmer mostly because of human activity such as burning fossil fuels (1)
- Don't know (9)

Q10 Do you agree that it is generally safe to eat foods grown with pesticides?

- Strongly Agree (5)
- Agree (4)
- Neutral (3)
- Disagree (2)
- Strongly Disagree (1)

Q10b Do you agree that it is generally safe to eat genetically engineered food?

- Strongly agree (5)
- Agree (4)
- Neutral (3)
- Disagree (2)
- Strongly Disagree (1)

Page Break

Q11 Do you believe that Covid epidemic really exists ?

- Strongly Agree (5)
- Agree (4)
- Neutral (3)
- Disagree (2)
- Strongly Disagree (1)

Q11b Do you believe that Covid could be an exaggeration of a new intense cold virus?

- Strongly Agree (5)
- Agree (4)
- Neutral (3)
- Disagree (2)
- Strongly Disagree (1)

End of Block: -Belief in the existence for SSIs

Start of Block: - Perception of scientists' consensus on SSIs

Q12 From what you've heard or read, do scientists generally agree that humans evolved over time ?

- Strongly Agree (5)
- Agree (4)
- Neutral (3)
- Disagree (2)
- Strongly Disagree (1)

Q13 From what you've heard or read, do scientists generally agree that the earth is getting warmer because of human activity ?

- Strongly Agree (5)
- Agree (4)
- Neutral (3)
- Disagree (2)
- Strongly Disagree (1)

Q14 From what you've heard or read, would you agree that scientists have a clear understanding of the health effects of genetically modified crops ?

○ Strongly Agree (5)

○ Agree (4)

○ Neutral (3)

○ Disagree (2)

○ Strongly Disagree (1)

Q15 From what you have heard or read, would you agree that scientists have a clear understanding of how to treat Covid virus ?

○ Strongly agree (5)

○ Agree (4)

○ Neutral (3)

○ Disagree (2)

○ Strongly Disagree (1)

End of Block: - Perception of scientists' consensus on SSIs

Start of Block: Science Knowledge Questions

Q16 Which of these is a major concern about the overuse of antibiotics ?

- ○ It can lead to antibiotic-resistant bacteria (5)
- ○ Antibiotics are very expensive (0)
- ○ People will become addicted to antibiotics (0)
- ○ Don’t know (9)

X→

Q17 Is the following statement true or false? Lasers work by focusing sound waves.

- ○ True (0)
- ○ False (5)
- ○ Don't know (9)

X→

Q18 Does nanotechnology deal with things that are extremely

- ○ Small (5)
- ○ Large (0)
- ○ Cold (0)
- ○ Hot (0)
- ○ Don't know (9)

Page Break

Q19 Which is an example of a chemical reaction?

- Water Boiling (0)
- Sugar Dissolving (0)
- Nails Rusting (5)
- Don't know (9)

Page Break

Q20 What is the main function of red blood cells? Is it...

- To fight disease in the body (0)
- To carry oxygen to all parts of the body (5)
- To help the blood to clot (0)
- Don't know (9)

Page Break

Q21 What gas do most scientists believe causes temperatures in the atmosphere to rise? Is it

- Carbon Dioxide (5)
- Hydrogen (0)
- Helium (0)
- Radon (0)
- Don't know (9)

Page Break

End of Block: Science Knowledge Questions

Start of Block: Demographics (Base/Universal)

Q22 What is your year of birth?

____

Q23 What is the highest level of school you have completed or the highest degree you have received?

- Less than high school (Grades 1-8 or no formal schooling) (1)
- High school incomplete (Grades 9-11 or Grade 12 with NO diploma) (2)
- High school graduate (Grade 12 diploma or equivalent including GED) (3)
- Some college but no degree (includes some community college) (4)
- Two year Associate degree in college or university (5)
- Four year college or university degree/Bachelor’s degree (e.g., BS, BA, AB) (6)
- Some postgraduate or professional schooling, no postgraduate degree (e.g. some graduate school) (7)
- Postgraduate or professional degree, including master’s, doctorate, medical or law degree (e.g., MA, MS, PhD, MD, JD, graduate school) (8)
- Don't know (9)

Display This Question:

If What is the highest level of school you have completed or the highest degree you have received? = Two year Associate degree in college or university

Or What is the highest level of school you have completed or the highest degree you have received? = Four year college or university degree/Bachelor's degree (e.g., BS, BA, AB)

Or What is the highest level of school you have completed or the highest degree you have received? = Some postgraduate or professional schooling, no postgraduate degree (e.g. some graduate school)

Or What is the highest level of school you have completed or the highest degree you have received? = Postgraduate or professional degree, including master's, doctorate, medical or law degree (e.g., MA, MS, PhD, MD, JD, graduate school)

Q23a Is your degree OR one or more of your degrees in a scientific field, or not?

- Yes (5)
- No (1)
- Don't know/can't answer (9)

Q24 Choose one or more ethnicities that you consider yourself to be: CHECK ALL THAT APPLY

- ☐ White (1)
- ☐ Hispanic or Latino (2)
- ☐ Black or African American (3)
- ☐ American Indian or Alaska Native (4)
- ☐ Asian or Asian - American (5)
- ☐ Native Hawaiian or Pacific Islander (6)
- ☐ Other (7) ____

Q25 What is your sex?

- ○ Male (1)
- ○ Female (2)
- ○ Both/Neither (3)

Q26 Information about income is very important to understand. Would you please give your best guess?Please indicate the answer that includes your entire household income in (previous year) before taxes.

- Less than $10,000 (1)
- $10,000 to $19,999 (2)
- $20,000 to $29,999 (3)
- $30,000 to $39,999 (4)
- $40,000 to $49,999 (5)
- $50,000 to $74,999 (6)
- $75,000 to $99,999 (7)
- $100,000 to $149,999 (8)
- $150,000 or more (10)

End of Block: Demographics (Base/Universal)

Start of Block: Demographics (Extended)

Q27 Are you now married, widowed, divorced, separated or never married?

- Married (1)
- Widowed (2)
- Divorced (3)
- Separated (4)
- Never Married (5)

Q28 How many people are living or staying at your address?

- 1 (1)
- 2 (2)
- 3 (3)
- 4 (4)
- 5 (5)
- 6 (6)
- More than 6 (7)

End of Block: Demographics (Extended)

Start of Block: Demographics (Employment)

Q29 Which statement best describes your current employment status?

- Working (paid employee) (1)
- Working (self-employed) (2)
- Not working (temporary layoff from a job) (3)
- Not working (looking for work) (4)
- Not working (retired) (5)
- Not working (disabled) (6)
- Prefer not to answer (9)

End of Block: Demographics (Employment)

Start of Block: Demographics (Political)

Q30 Generally speaking, do you usually think of yourself as a Republican, a Democrat, an Independent, or something else?

- Republican (1)
- Democrat (2)
- Independent (3)
- Other (please write in the box below) (7) ____
- Not sure/don't want to share (9)

Display This Question:

If Generally speaking, do you usually think of yourself as a Republican, a Democrat, an Independent,... = Independent

Q31 Do you think of yourself as closer to the Republican or Democratic party?

- Republican (1)
- Democratic (2)

Q32 Here is a 5-point scale on which the political views that people might hold are arranged from extremely conservative (left) to extremely liberal (right). Where would you place yourself on this scale?

- ○ Extremely conservative (1)
- ○ Conservative (2)
- ○ Neutral (3)
- ○ Liberal (4)
- ○ Extremely liberal (5)

End of Block: Demographics (Political)

Appendix II. Questionnaire tool for study 2

ASK ALL:

Q1 All in all, are you satisfied or dissatisfied with the way things are going in this country today?

1 Satisfied

2 Dissatisfied

9 Don't know/Refused (VOL.)

ASK ALL:

Q2 We'd like you to compare the United States to other industrialized countries in a few different areas. (First,) what about... **[INSERT ITEM; READ AND RANDOMIZE]**? **[READ FOR FIRST ITEM, THEN AS NECESSARY:** Do you think the U.S. is the BEST IN THE WORLD, above average, average or below average in **[ITEM]** compared to other industrialized countries?]

a. Its scientific achievements

b. Its military

c. Its economy

NO ITEM D

e. Science, technology, engineering and math education for grades K to 12

f. Its political system

FORM 1 ONLY:

gF1. Medical treatment

FORM 2 ONLY:

hF2 Its health care

RESPONSE CATEGORIES

1 Best in the world

2 Above average

3 Average

4 Below average

9 Don't know/Refused (VOL.)

ASK ALL:

Now I'd like to ask you some questions about science.

Q3 How much do you ENJOY keeping up with news about science – a lot, some, not much, or not at all?

1 A lot

2 Some

3 Not much

4 Not at all

9 Don't know/Refused **(VOL.)**

ASK ALL:

Q4 Overall, has science made life easier or more difficult for most people?

1 Easier
2 More difficult
3 Not had much of an effect **(VOL.)**
9 Don’t know/Refused **(VOL.)**

ASK ALL:

Q5 Has science had a mostly positive or mostly negative effect on the quality of **[INSERT ITEM; RANDOMIZE]** in the U.S.? What about **[NEXT ITEM]**? [**IF NECESSARY**: Has science had a mostly positive or mostly negative effect on the quality of **[ITEM]** in the U.S.?]

a. Food

b. Health care

c. The environment

RESPONSE CATEGORIES

1 Mostly positive

2 Mostly negative

3 Not had much of an effect **(VOL.)**

9 Don't know/Refused **(VOL.)**

ASK ALL

Q6 Which of these statements best describes your views, even if neither is exactly right?

[READ; DO NOT RANDOMIZE RESPONSE OPTIONS]

1 One, Public opinion should play an important role to guide policy decisions about scientific issues, OR

2 Two, Public opinion should NOT play an important role to guide policy decisions about scientific issues because these issues are too complex for the average person to understand

3 Neither/Both **[VOL. DO NOT READ]**

9 Don't know/Refused **(VOL.)**

ASK ALL:

Q7 In your opinion, generally do you think... **[READ AND RANDOMIZE]**

1 Science and religion are often in conflict [OR]

2 Science and religion are mostly compatible

9 **[VOL. DO NOT READ]** Don't know/Refused

ASK ALL:

Q8 Now thinking about your own religious beliefs, does science sometimes conflict with your own religious beliefs, or doesn't it?

1 Yes, science conflicts with own religious beliefs

2 No, science does not conflict with own religious beliefs

9 Don't know/Refused **(VOL.)**

IF Q8=1 AND FORM 1, ASK:

Q9F1 Can you tell me some ways in which science conflicts with your own religious beliefs? [OPEN END; ACCEPT UP TO THREE RESPONSES; PROBE ONCE IF "DON'T KNOW," AND PROBE FOR CLARITY, BUT DO NOT PROBE FOR ADDITIONAL RESPONSES]

1 Answer given

9 Don't know/Refused

NOTE: Verbatim responses are held to protect respondent confidentiality. Coded responses are included below

Q9f1_code1 FIRST MENTION: Can you tell some ways in which science conflicts with your own religious beliefs?

VERBATIM RESPONSES CODED INTO THE FOLLOWING CATEGORIES

1 Abortion
2 Evolution, Creation, Darwinism
3 Global warming/climate change
4 Belief in God or denial of God by others
5 Stem cell research
6 Belief in Bible, miracles, or conflict with Bible
7 Medical, pills, blood transfusion, natural healing
8 Cloning or animals and cloning
9 Birth control or artificial insemination
10 Euthanasia, right to die
11 Gay marriage, homosexuality
12 Vaccinations

13	Space travel, exploration of universe
18	Life after death beliefs
30	Genetics, genetic engineering
35	Belief in science, not religion
36	Schools/News media/Political leaders
50	General—science and religion conflict
98	Other—unclear response
99	Don't know

Q9f1_code2 SECOND MENTION: Can you tell some ways in which science conflicts with your own religious beliefs?

VERBATIM RESPONSES CODED INTO THE FOLLOWING CATEGORIES

1	Abortion
2	Evolution, Creation, Darwinism
3	Global warming/climate change
4	Belief in God or denial of God by others
5	Stem cell research
6	Belief in Bible, miracles, or conflict with Bible
7	Medical, pills, blood transfusion, natural healing
8	Cloning or animals and cloning
9	Birth control or artificial insemination
10	Euthanasia, right to die
11	Gay marriage, homosexuality
12	Vaccinations
13	Space travel, exploration of universe
18	Life after death beliefs
30	Genetics, genetic engineering
35	Belief in science, not religion
36	Schools/News media/Political leaders
50	General—science and religion conflict
98	Other—unclear response
99	Don’t know

Q9f1_code3 THIRD MENTION: Can you tell some ways in which science conflicts with your own religious beliefs?

VERBATIM RESPONSES CODED INTO THE FOLLOWING CATEGORIES

1	Abortion
2	Evolution, Creation, Darwinism
3	Global warming/climate change
4	Belief in God or denial of God by others
5	Stem cell research
6	Belief in Bible, miracles, or conflict with Bible
7	Medical, pills, blood transfusion, natural healing
8	Cloning or animals and cloning
9	Birth control or artificial insemination
10	Euthanasia, right to die
11	Gay marriage, homosexuality
12	Vaccinations
13	Space travel, exploration of universe
18	Life after death beliefs
30	Genetics, genetic engineering
35	Belief in science, not religion
36	Schools/News media/Political leaders
50	General—science and religion conflict
98	Other—unclear response
99	Don’t know

NO QUESTION 10 THROUGH 11

ASK ALL:

Q12 In your opinion, do government investments in [INSERT ITEM; RANDOMIZE] usually pay off in the long run, or are they not worth it*?*

a. Basic scientific research

b. Engineering and technology

RESPONSE CATEGORIES

1	Yes, pay off in long run

2 No, aren't worth it

9 Don't know/Refused (VOL.)

ASK ALL:

Q13 Which of these comes closer to your view? **[READ AND RANDOMIZE RESPONSE OPTIONS]**

1 Government investment in research is ESSENTIAL for scientific progress [OR]

2 Private investment will ensure that enough scientific progress is made, even without government investment

9 **[VOL. DO NOT READ]** Don't know/Refused

NO QUESTION 14 THROUGH 15

[RANDOMIZE QUESTIONS 16-18 IN BLOCKS WITH QUESTIONS Q20F1 to Q23 IN BLOCKS]

ASK ALL:

Now a few questions about some issues...

ASK ALL:

Q16 Which comes closer to your view? **[READ AND RANDOMIZE]**

1 Humans and other living things have evolved over time **[OR]**

2 Humans and other living things have existed in their present form since the beginning of time

9 **[VOL. DO NOT READ]** Don't know/Refused

IF EVOLVED (1 in Q16), ASK:

Q17 And do you think that...**[READ OPTIONS AND RANDOMIZE]**?

1 Humans and other living things have evolved due to natural processes such as natural selection, OR

2 A supreme being guided the evolution of living things for the purpose of creating humans and other life in the form it exists today

9 **[VOL. DO NOT READ]** Don’t know/Refused

ASK ALL:

Q18 From what you’ve heard or read, do scientists generally agree that humans evolved over time, or do they not generally agree about this?

1 Yes, scientists generally agree that humans evolved over time

2 No, scientists do not generally agree that humans evolved over time

9 Don’t know/Refused **(VOL.)**

NO QUESTION 19

ASK FORM 1 ONLY:

Q20F1 Which of these three statements about the earth's temperature comes closest to your view?

[READ AND RANDOMIZE FIRST TWO OPTIONS; KEEP THIRD OPTION LAST]:

1 The earth is getting warmer mostly because of natural patterns in the earth's environment

2 The earth is getting warmer mostly because of human activity such as burning fossil fuels [OR]

3 **[READ LAST]** There is no solid evidence that the earth is getting warmer

9 **[VOL. DO NOT READ]** Don't know/Refused

ASK FORM 2 ONLY:

Q21AF2 From what you've read and heard, is there solid evidence that the average temperature on earth has been getting warmer over the past few decades, or not?

1 Yes

2 No

3 Mixed/some evidence **(VOL.)**

9 Don't know/Refused **(VOL.)**

ASK IF EARTH IS GETTING WARMER (Q.21AF2=1):

Q21BF2 Do you believe that the earth is getting warmer **[READ AND RANDOMIZE]**?

1 Mostly because of human activity such as burning fossil fuels [OR]

2 Mostly because of natural patterns in the earth's environment

9 **[VOL. DO NOT READ]** Don't know/Refused

ASK IF EARTH IS NOT GETTING WARMER (Q.21AF2=2):

Q21CF2 Do you think that we just don't know enough yet about whether the Earth is getting warmer or do you think it's just not happening?

1 Just don't know enough yet

2 Just not happening

9 Don't know/Refused **(VOL.)**

NO QUESTION 22

ASK ALL:

Q23 From what you've heard or read, do scientists generally agree that the earth is getting warmer because of human activity, or do they not generally agree about this?

1 Yes, scientists generally agree that the earth is getting warmer because of human activity

2 No, do not generally agree that the earth is getting warmer because of human activity

9 Don't know/Refused **(VOL.)**

ASK ALL:

On another topic.

Q24 All in all, do you favor or oppose **[INSERT ITEM; RANDOMIZE]**? Do you favor or oppose **[NEXT ITEM]**?

a. The use of animals in scientific research

b. Building more nuclear power plants to generate electricity

c. The increased use of fracking, a drilling method that uses high-pressure water and chemicals to extract oil and natural gas from underground rock formations

d. The increased use of genetically engineered plants to create a liquid fuel replacement for gasoline

e. Allowing more offshore oil and gas drilling in U.S. waters

f. Allowing more people access to experimental drugs before clinical trials have shown the drugs to be safe and effective for that disease or condition

RESPONSE CATEGORIES

1 Favor

2 Oppose

9 Don’t know/Refused **(VOL.)**

ASK ALL:

Q25 Thinking about childhood diseases, such as measles, mumps, rubella and polio... **[READ AND RANDOMIZE]**

1 Should parents be able to decide NOT to vaccinate their children [OR]

2 Should all children be required to be vaccinated

9 Don’t know/Refused (VOL.)

NO QUESTION 26

ASK ALL:

Q27 Thinking about the use of biological engineering to create artificial organs for humans needing a transplant operation, would you say this is making appropriate use of medical advances OR is it taking medical advances too far?

1 Appropriate use of medical advances

2 Taking medical advances too far

9 Don't know/Refused (VOL.)

ASK ALL:

Q28 Which of these statements comes closest to your point of view, even if neither is exactly right? **[READ IN ORDER**]

1 One, The growing world population will NOT be a major problem because we will find a way to stretch our natural resources OR

2 Two, The growing population WILL be a major problem because there won’t be enough food and resources to go around?

9 Don't know/Refused (VOL.)

ASK ALL:

On another topic.

Q29 Do you think the SPACE STATION has been a good investment for this country, or don't you think so?

1 Good investment
2 Not a good investment
9 Don't know/Refused **(VOL.)**

ASK ALL:

Q30 The cost of sending human astronauts to space is considerably greater than the cost of using robotic machines for space exploration. As you think about the future of the U.S. space program, do you think it is essential or not essential to include the use of human astronauts in space?

1 Essential
2 Not essential
9 Don't know/Refused **(VOL.)**

NO QUESTION 31

ASK ALL:

Q32 From what you've heard or read, would you say that **[READ AND RANDOMIZE 1-2]**

1 Scientists generally believe that the universe was created in a single, violent event, often called "the Big Bang" OR
2 Scientists are divided in their views about how the universe was created
3 Both/Neither **(VOL.)**
9 Don't know/Refused **(VOL.)**

[RANDOMIZE ORDER OF Q33 AND Q34]

ASK ALL:

Q33 Would you say that changing a baby's genetic characteristics to make the baby more intelligent is making appropriate use of medical advances OR is it taking medical advances too far?

1 Appropriate use of medical advances

2 Taking medical advances too far

9 Don't know/Refused **(VOL.)**

ASK ALL:

Q34 Would you say that changing a baby's genetic characteristics to reduce the risk of serious diseases is making appropriate use of medical advances OR is it taking medical advances too far?

1 Appropriate use of medical advances

2 Taking medical advances too far

9 Don't know/Refused **(VOL.)**

ASK ALL:

On a different topic.

Q35 Do you think it is generally safe or unsafe to eat foods grown with pesticides?

1 Generally safe

2 Generally unsafe

9 Don't know/Refused **(VOL.)**

NO QUESTION 36

ASK ALL: Scientists can change the genes in some food crops and farm animals to make them grow faster or bigger and be more resistant to bugs, weeds, and disease.

ASK ALL:

Q37 When you are food shopping, how often, if ever, do you LOOK TO SEE if the products are genetically modified? **[READ]**

1 Always

2 Sometimes

3 Not too often, OR

4 Never

5 Someone else in HH does the food shopping **(VOL.)**

9 Don’t know/Refused **(VOL.)**

ASK ALL:

Q38 Do you think it is generally safe or unsafe to eat genetically modified foods?

1 Generally safe

2 Generally UNsafe

9 Don't know/Refused **(VOL.)**

ASK ALL:

Q39 From what you've heard or read, would you say scientists have a clear understanding of the health effects of genetically modified crops OR are scientists NOT clear about this?

1 Scientists have a clear understanding

2 Scientists do NOT have a clear understanding

9 Don't know/Refused **(VOL.)**

ASK ALL:

Q40 Which of these statements best describes your views, even if neither is exactly right?
[READ; RANDOMIZE RESPONSE OPTIONS]

1 Churches and other houses of worship should express their views about policy decisions on scientific issues

2 Churches and other houses of worship should keep out of policy decisions on scientific issues

3 Neither/Both **[VOL. DO NOT READ]**

9 Don't know/Refused **(VOL.)**

ASK ALL:

Q41 Just your impression: Do you think of scientists as...**[RANDOMIZE ORDER OF:]** a politically liberal group/a politically conservative group **[THEN]** or as neither in particular?

1 A politically liberal group

2 A politically conservative group

3 Neither in particular

9 Don't know/Refused **(VOL.)**

ASK ALL:

Here's a different kind of question. As far as you know...

[RANDOMIZE KNOSCT14 THROUGH KNOSCT19]

ASK ALL:

KNOSCT14 Which of these is a major concern about the overuse of antibiotics? **[READ AND RANDOMIZE]**

[**INTERVIEWER NOTE: IF NO ANSWER, PROBE ONCE**: We're just looking for your best guess on this.]

1 It can lead to antibiotic resistant bacteria *(Correct)*

2 Antibiotics are very expensive

3 People will become addicted to antibiotics

8 (VOL.) Don't know

9 (VOL.) Refused

ASK ALL:

KNOSCT15 Is the following statement true or false? Lasers work by focusing sound waves. [**IF NECESSARY**: Is this statement true or false?]

[**INTERVIEWER NOTE: IF NO ANSWER, PROBE ONCE**: We're just looking for your best guess on this.]

1 True

2 False *(Correct)*

8 **(VOL.)** Don't know

9 **(VOL.)** Refused

ASK ALL:

KNOSCT16 Does nanotechnology deal with things that are extremely **[READ AND RANDOMIZE]**

[**INTERVIEWER NOTE: IF NO ANSWER, PROBE ONCE**: We're just looking for your best guess on this.]

1 Small *(Correct)*

2 Large

3 Cold [OR]

4 Hot

8 **(VOL.)** Don't know

9 **(VOL.)** Refused

ASK ALL:

KNOSCT17 Which is an example of a chemical reaction? **[READ AND RANDOMIZE]**

[**INTERVIEWER NOTE: IF NO ANSWER, PROBE ONCE**: We're just looking for your best guess on this.]

1 Water boiling
2 Sugar dissolving [OR]
3 Nails rusting *(Correct)*
8 **(VOL.)** Don't know
9 **(VOL.)** Refused

ASK ALL:

KNOSCT18 What is the main function of red blood cells? Is it... **[READ AND RANDOMIZE]**

[**INTERVIEWER NOTE: IF NO ANSWER, PROBE ONCE**: We're just looking for your best guess on this.]

1 To fight disease in the body
2 To carry oxygen to all parts of the body [OR] *(Correct)*
3 To help the blood to clot
8 **(VOL.)** Don't know
9 **(VOL.)** Refused

ASK ALL:

KNOSCT19 What gas do most scientists believe causes temperatures in the atmosphere to rise? Is it [**READ AND RANDOMIZE**]

[**INTERVIEWER NOTE: IF NO ANSWER, PROBE ONCE**: We're just looking for your best guess on this.]

1 Carbon dioxide *(Correct)*
2 Hydrogen [OR]
3 Helium
4 Radon
8 **(VOL.)** Don't know

9 **(VOL.)** Refused

KNOSCT_COUNT Count of correct answers to the science knowledge questions

0 None correct
1 1 correct
2 2 correct
3 3 correct
4 4 correct
5 5 correct
6 6 correct

ASK ALL:
Now, just a few questions for statistical purposes only

SEXZ Just to confirm, are you male or female? **[DO NOT READ LIST]**

1 Male
2 Female
3 Other **(VOL.)**
8 Don't know **(VOL.)**
9 Refused **(VOL.)**

ASK ALL:
AGEREC (Recoded AGE) What is your age?

____ years
90 90 or older
99 Don't know/Refused (VOL.)

ASK ALL:

EDUC2 What is the highest level of school you have completed or the highest degree you have received? **[DO NOT READ]**

1 Less than high school (Grades 1-8 or no formal schooling)

2 High school incomplete (Grades 9-11 or Grade 12 with NO diploma)

3 High school graduate (Grade 12 with diploma or GED certificate)

4 Some college, no degree (includes some community college)

5 Two year associate degree from a college or university

6 Four year college or university degree/Bachelor's degree (e.g., BS, BA, AB)

7 Some postgraduate or professional schooling, no postgraduate degree (e.g. some graduate school)

8 Postgraduate or professional degree, including master's, doctorate, medical or law degree (e.g., MA, MS, PhD, MD, JD, graduate school)

9 Don't know/Refused

[MAKE FULL NOTE AVAILABLE FOR INTERVIEWERS: Enter code 3-HS graduate if R completed vocational, business, technical, or training courses after high school that did NOT count toward an associate degree from a college, community college or university (e.g., training for a certificate or an apprenticeship)]

ASK IF EDUC2=6,7,8:

SCIDEG [**INSERT IF EDUC2=6,7**: your degree] [**INSERT IF EDUC2=8**: one or more of your degrees] in a scientific field, or not?

[INTERVIEWER NOTE: IF RESPONDENT CANNOT ANSWER BUT OFFERS DEGREE/AREA OF STUDY, PLEASE RECORD.]

1 Yes

2 No

3 Can't answer, listed area of study [SPECIFY] (VOL.)

9 Don't know/Refused (VOL.)

ASK ALL:

HISP Are you of Hispanic, Latino, or Spanish origin, such as Mexican, Puerto Rican or Cuban?

1 Yes

2 No

9 Don't know/Refused (VOL.)

ASK ALL:

RACE Which of the following describes your race? You can select as many as apply. White, Black or African American, Asian or Asian American or some other race. **[RECORD UP TO FOUR IN ORDER MENTIONED BUT DO NOT PROBE FOR ADDITIONAL] [IF R VOLS MIXED BIRACIAL, PROBE ONCE:** What race or races is that?**]**

RACECMB combined variable created based on responses to RACE
RACE3m1 first mention
RACE3m2 second mention
RACE3m3 third mention
RACE3m4 fourth mention

1 White (e.g., Caucasian, European, Irish, Italian, Arab, Middle Eastern)
2 Black or African-American (e.g., Negro, Kenyan, Nigerian, Haitian)
3 Asian or Asian-American (e.g., Asian Indian, Chinese, Filipino, Vietnamese or other Asian origin groups)
4 Some other race **(SPECIFY____ IF NEEDED:** What race or races is that?**)**
5 Native American/American Indian/Alaska Native **(VOL.)**
6 Pacific Islander/Native Hawaiian **(VOL.)**
7 Hispanic/Latino **(VOL.)** (e.g., Mexican, Puerto Rican, Cuban)
8 Don't know **(VOL.)**
9 Refused (e.g., non-race answers like American, Human, purple) **(VOL.)**

ASK ALL:

RACETHN Race/ethnicity based on responses from HISP and RACE

1 White non-Hispanic

2 Black non-Hispanic

3 Hispanic

4 Other

9 Don’t know/Refused **(VOL.)**

ASK IF HISPANIC (HISP=1 OR RACE=7):

BIRTH_HISP Were you born in the United States, on the island of Puerto Rico, or in another country?

1 U.S.
2 Puerto Rico
3 Another country
9 Don't know/Refused **(VOL.)**

ASK IF NOT HISPANIC (HISP=2,9 AND RACE≠7):

USBORN Were you born in the United States or in another country?

1 Yes, born in U.S.
2 No, some other country
3 Puerto Rico **(VOL.)**
4 Other U.S. Territories (includes Guam, Samoa, U.S. Virgin Islands) **(VOL.)**
9 Don't know/Refused **(VOL.)**

ASK ALL:

MARITAL Are you currently married, living with a partner, divorced, separated, widowed, or have you never been married? **[IF R SAYS "SINGLE," PROBE TO DETERMINE WHICH CATEGORY IS APPROPRIATE]**

1 Married
2 Living with a partner
3 Divorced
4 Separated
5 Widowed
6 Never been married
9 Don't know/Refused **(VOL.)**

ASK ALL:

PARENT Are you the parent or guardian of any children under 18 now living in your household?

1 Yes

2 No

9 Don't know/Refused **(VOL.)**

ASK IF NOT BORN IN US, PUERTO RICO OR US TERRITORIES (BIRTH_HISP=3,9 OR USBORN=2,9):

CITIZEN Are you a citizen of the United States, or not? {QID:citizen_meth}

1 Yes
2 No
9 Don't know/Refused **(VOL.)**

ASK ALL:

RELIG What is your present religion, if any? Are you Protestant, Roman Catholic, Mormon, Orthodox such as Greek or Russian Orthodox, Jewish, Muslim, Buddhist, Hindu, atheist, agnostic, something else, or nothing in particular?

[INTERVIEWER: IF R VOLUNTEERS "nothing in particular, none, no religion, etc." BEFORE REACHING END OF LIST, PROMPT WITH: And would you say that's atheist, agnostic, or just nothing in particular?]

1 Protestant (Baptist, Methodist, Non-denominational, Lutheran, Presbyterian, Pentecostal, Episcopalian, Reformed, Church of Christ, etc.)

2 Roman Catholic (Catholic)

3 Mormon (Church of Jesus Christ of Latter-day Saints/LDS)

4 Orthodox (Greek, Russian, or some other orthodox church)

5 Jewish (Judaism)

6 Muslim (Islam)

7 Buddhist

8 Hindu

9 Atheist (do not believe in God)

10 Agnostic (not sure if there is a God)

11 Something else **(SPECIFY:______)**

12 Nothing in particular

13 Christian **(VOL.)**

14 Unitarian (Universalist) **(VOL.)**

15 Jehovah's Witness **(VOL.)**

99 Don't Know/Refused **(VOL.)**

ASK IF SOMETHING ELSE OR DK/REF (RELIG=11, 99):

CHR Do you think of yourself as a Christian or not? **[IF R NAMED A NON-CHRISTIAN RELIGION IN PREVIOUS QUESTION (e.g. Native American, Wiccan, Pagan, etc.), DO NOT READ (ENTER "NO" CODE 2)]**

1 Yes

2 No

9 Don't know/Refused **(VOL.)**

ASK IF CHRISTIAN (RELIG=1-4, 13,15 OR CHR=1):

BORN Would you describe yourself as a "born again" or evangelical Christian, or not?

1 Yes, would

2 No, would not

9 Don't know/Refused **(VOL.)**

ASK ALL:

ATTEND Aside from weddings and funerals, how often do you attend religious services... more than once a week, once a week, once or twice a month, a few times a year, seldom, or never?

1 More than once a week

2 Once a week

3 Once or twice a month

4 A few times a year

5 Seldom

6 Never

9 Don't know/Refused **(VOL.)**

ASK ALL:

INCOME Last year, that is in 2013, what was your total family income from all sources, before taxes? Just stop me when I get to the right category. **[READ]**

1 Less than $10,000

2 10 to under $20,000

3 20 to under $30,000

4 30 to under $40,000

5 40 to under $50,000

6 50 to under $75,000

7 75 to under $100,000

8 100 to under $150,000 [OR]

9 $150,000 or more

10 **[VOL. DO NOT READ]** Don't know/Refused

ASK ALL:

REG Which of these statements best describes you? **[READ IN ORDER] [INSTRUCTION: BE SURE TO CLARIFY WHETHER RESPONDENT IS ABSOLUTELY CERTAIN THEY ARE REGISTERED OR ONLY PROBABLY REGISTERED; IF RESPONDENT VOLUNTEERS THAT THEY ARE IN NORTH DAKOTA AND DON'T HAVE TO REGISTER, PUNCH 1]**

1 Are you ABSOLUTELY CERTAIN that you are registered to vote at your current address [OR]

2 Are you PROBABLY registered, but there is a chance your registration has lapsed [OR]

3 Are you NOT registered to vote at your current address

9 **[VOL. DO NOT READ]** Don't know/Refused

ASK ALL:

PARTY In politics TODAY, do you consider yourself a Republican, Democrat, or independent?

1 Republican

2 Democrat

3 Independent

4 No preference **(VOL.)**

5 Other party **(VOL.)**

9 Don't know/Refused **(VOL.)**

ASK IF INDEP/NO PREF/OTHER/DK/REF (PARTY=3,4,5,9):

PARTYLN As of today do you lean more to the Republican Party or more to the Democratic Party?

1 Republican
2 Democrat
9 Other/Don't know/Refused **(VOL.)**

ASK ALL:

IDEO In general, would you describe your political views as... **[READ]**

1 Very conservative
2 Conservative
3 Moderate
4 Liberal [OR]
5 Very liberal
9 **[VOL. DO NOT READ]** Don't know/Refused

ASK ALL:

HH1 How many people, including yourself, live in your household?
INTERVIEWER NOTE: HOUSEHOLD MEMBERS INCLUDE PEOPLE WHO THINK OF THIS HOUSEHOLD AS THEIR PRIMARY PLACE OF RESIDENCE, INCLUDING THOSE WHO ARE TEMPORARILY AWAY ON BUSINESS, VACATION, IN A HOSPITAL, OR AWAY AT SCHOOL. THIS INCLUDES INFANTS, CHILDREN AND ADULTS.

1 One
2 Two
3 Three
4 Four
5 Five
6 Six
7 Seven
8 Eight or more
9 Don’t know/Refused

ASK IF MORE THAN ONE PERSON IN HH (HH1>1):
HH3 How many, including yourself, are adults, age 18 and older?

1 One
2 Two
3 Three
4 Four
5 Five
6 Six
7 Seven
8 Eight or More
9 Don't know/Refused

ASK ALL:
EMINUSE Do you use the internet or email, at least occasionally?

1 Yes
2 No
8 Don't know **(VOL.)**
9 Refused **(VOL.)**

ASK ALL:
INTMOB Do you access the internet on a cell phone, tablet or other mobile handheld device, at least occasionally?

1 Yes
2 No
8 Don't know **(VOL.)**
9 Refused **(VOL.)**

ASK ALL LANDLINE SAMPLE:
QL1. Now thinking about your telephone use... Do you have a working cell phone?

1 Yes, have cell phone
2 No, do not
9 Don't know/Refused **(VOL.)**

ASK IF NO CELL PHONE AND MULTI-PERSON HOUSEHOLD (QL1=2,9 AND HH1>1):

QL1a. Does anyone in your household have a working cell phone?

1 Yes, someone in household has cell phone
2 No
9 Don't know/Refused **(VOL.)**

ASK ALL CELL PHONE SAMPLE:

QC1. Now thinking about your telephone use... Is there at least one telephone INSIDE your home that is currently working and is not a cell phone?

1 Yes home telephone
2 No, no home telephone
9 Don't know/Refused **(VOL.)**

Appendix III. IRB Letters

Claremont Graduate University
Institutional Review Board

Dear Burcu,

Thank you for submitting your research protocol to the IRB at Claremont Graduate University for review. On 12/09/2020, based on the information provided for Protocol #3866 (U.S. citizens public perception of Socio-scientific issues), we have certified it as *exempt from IRB supervision* under CGU policy and federal regulations at 45 CFR 46.104(b)(2).

Exempt status means that so long as the study does not vary significantly from the description you have given us, further review in the form of filing annual reports and/or renewal requests is not necessary. Although study termination/closure reports are also not required, they are greatly appreciated. You may specify in relevant study documents, such as consent forms, that CGU human subjects protection staff members have reviewed the study and determined it to be exempt from IRB supervision. The IRB does not "*approve*" (or disapprove) studies that are exempt, so kindly avoid use of this verb.

If we have approved informed consent/assent forms for your study, please be sure to use the approved versions when obtaining consent from research subjects.

Please note carefully that maintaining exempt status requires that (a) the risks of the study *remain minimal*, that is, as described in the application; (b) that *anonymity or confidentiality* of participants, *or protection* of participants against any higher level of risk due to the internal knowledge or disclosure of identity by the researcher, is maintained as described in the application; (c) that *no deception* is introduced, such as reducing the accuracy or specificity of information about the research protocol that is given to prospective participants; (d) the research *purpose*, *sponsor*, and recruited *study population* remain as described; and (e) the principal investigator (PI) continues and is not replaced.

Changes in *any such features* of the study as described may affect one or more of the conditions of exemption and would very likely warrant a reclassification of the research protocol from exempt status and require additional IRB review. If any such changes are contemplated, please notify the IRB as soon as possible and before the study is begun or changes are implemented. If any events occur during the course of research, such as unexpected adverse consequences to participants, that call into question the features that permitted a determination of exempt status, you must notify the IRB as soon as possible.

Please note that a series of suggestions may also be attached to this email. These are suggestions to develop or improve your research protocol. These suggestions are highly recommended but not required. You do not need to send anything back to the IRB.

If Applicable: Most listservs, websites, and bulletin boards have policies regulating the types of advertisements or solicitations that may be posted, including from whom prior approval must be obtained. Many institutions and even classroom instructors have policies regarding who can solicit potential research participants from among their students, employees, etc., what information must be included in solicitations, and how recruitment notices are distributed or posted. You should familiarize yourself with the policies and approval procedures required of you to recruit for or conduct your study by listservs, websites, institutions, and/or instructors. Approval or exemption by the CGU IRB does not substitute for these approvals or release you from assuring that you have gained appropriate approvals before advertising or conducting your study in such venues.

The IRB may be reached at (909) 607-9406 or via email to irb@cgu.edu. The IRB wishes you well in the conduct of your research project.

Sincerely,
Carrie Herr
Office of Research, Sponsored Programs and Grants Administrative Assistant
carrie.herr@cgu.edu

Claremont Graduate University
Institutional Review Board

Claremont Graduate University IRB	*Scheduled Follow-up Notification*

To: Burcu Demiralp
From: CGU IRB
Subject: IRB Protocol #3866
Date: 12/09/2021

The protocol entitled "*U.S. citizens public perception of Socio-scientific issues*" was approved on 12/09/2020. While there is no requirement for annual or continuing review of this protocol, we do ask you to terminate the protocol when your work is complete. You may terminate the protocol by returning the view protocol page in Mentor IRB and clicking the "Terminate Protocol" button at the top of the page.

Best wishes for your research work.

Sincerely,
Andrew Conway, Ph.D.
andrew.conway@cgu.edu

150 East Tenth Street ● Claremont, California 91711-6160