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Article

The Effect of Statement Biased Popular Media Consumption on Public Perceptions of Nuclear Power

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ABSTRACT

This study assesses the effect of popular media consumption, as a function of education level, on the public's opinions about nuclear power. Opinions concerning ten statements about nuclear power were collected before and after participants read a news article in support of or in opposition to nuclear power. The purpose of the study was to determine the degree of malleability of people's opinions about nuclear power and whether this malleability increased or decreased with the subject's education level (high school students, college students, and college graduates). We hypothesized that, despite an evident agenda by the article's author, public viewpoints on nuclear power may fluctuate from their original standpoints after reading the article. The results indicate that participants, regardless of education level, were willing to change their opinions about nuclear power after consuming a single popular media article. After reading the media article, supporting nuclear power, participants showed more positive opinions about nuclear power. Conversely, participants who consumed the media article and were critical of nuclear power showed a more negative overall opinion about nuclear power. This indicates that respondents, regardless of education level, are open to modifying their opinions about nuclear power after consuming popular media, even if the media has a clear statement bias in support of nuclear power or against it.

INTRODUCTION

Public opinions concerning nuclear power took an abrupt negative turn after the Chernobyl disaster in 1986 (1,2). Public sentiment toward the benefits of nuclear power, however, began to display an increasingly positive rebound a year or so later (2,3). In the mid to late 2000s, public opinion had largely swung back in favor of nuclear power. Factors such as 32 years without a major nuclear incident, technological developments in nuclear safety, and an energy policy promoted nuclear power as a valuable component of the country's energy mix (4). Public opinion began to fluctuate based on media coverage and foreign affairs. Prior to the meltdown of the Fukushima Daiichi Nuclear Power Plant in Japan in 2011, nuclear power had gained an increase in public interest due to positive portrayal by the media and specific global referendums assessing support (5). In contrast, after the power plant's meltdown, the public's opinions of nuclear power again took a strong downturn (5,6) , thus ending what was perceived by many to be a resurgence in support for new nuclear construction (4). Public opinion surveys indicated that people's perceptions of the benefits of nuclear power did not shift after the Fukushima disaster. In contrast, public trust in the safety of nuclear power strongly declined, resulting in an overall decrease in support for nuclear power. In Australia, public support for nuclear power as a tool to combat climate change was at 42% in 2010, while only 30.5% of respondents believed that nuclear power should not be used to decrease the impacts of climate change. The same survey given in 2012, after the Fukushima disaster, showed a dramatic reversal in this trend. In 2012, 40.1% of respondents disagreed that nuclear power should be used to combat climate change, while only 34.4% of respondents agreed (4). A similar erosion in support of nuclear power after the Fukushima incident was also observed in Japan, China, Germany, Switzerland, Belgium, Italy, and many other countries (8-14).

Given the short time frame of the loss of public support for nuclear power after the Chernobyl disaster (2), we might expect public support for nuclear power to have recovered by now, due to the seven years that have elapsed since the Fukushima disaster. Changes in our society since the 1990s, however, may be responsible for the fact that this has not occurred. One of the main changes is the ease of access to information. The internet and the 24-hour news cycle provide a plethora of information that is accessible to the public at any time. The purpose of this study was to elucidate the degree to which the consumption of statement-biased popular media, either in support of nuclear power or against it, could affect people's opinions about the impact of nuclear power on society. Statement bias is when a media source, which ideally should convey an objective position that explores all facets of an issue, instead expresses a position that is clearly favorable or unfavorable towards a topic, offering only a partial perspective (15). Approximately half of respondents were presented with a news story that demonstrated statement bias in support of nuclear power (positively statement biased), and approximately half of respondents were presented with a news story that demonstrated statement bias against nuclear power (negatively statement biased). This approach aims to inform our understanding of the malleability of public opinion on this issue at an educational level. High school students,

college students, and college graduate's opinion fluctuation became measured between pre-test, and post-test.

These questions are of particular importance in the state of Georgia, where the construction of new nuclear reactors at Plant Vogtle in Waynesboro has generated significant controversy. The two new nuclear reactors are the first built in the United States in over 30 years and have generated a significant amount of both support and opposition from the public of Georgia. Though locally important, the new nuclear reactors at Plant Vogtle are also nationally and internationally relevant. These nuclear reactors are currently the only nuclear reactors under construction in the United States (16). The reactors represent a shift in priority away from generating cheap electricity and towards generating a higher portion of carbon-neutral baseload electricity (R. Just, personal communication, August 3, 2017). Culley, et al. (2010) discovered the presence of media framing, similar to statement bias, on the topic of nuclear energy in the case of Georgia's Plant Vogtle since 2010. The Augusta Chronicle and Atlanta Journal Constitution, two examples of popular media in Georgia, clearly present certain articles in a positive or negative view of nuclear power without defining the article as an opinion piece. Supposedly "unbiased media," specifically concerning Plant Vogtle, display serious opinionated pieces that are consumed by a mass audience. Some articles addressed carbon neutral arguments in both positive and negative spectrums, as it is a vital discussion in Plant Vogtle's development (17). This is an acknowledgement of the very real potential for future regulation of carbon dioxide emissions by the United States government (17, 18). The regulation of carbon dioxide is already a reality for many countries in Europe19 as well as globally (20,21,22).Some forward thinking companies are already planning for a future where such regulations exist in the United States. Nuclear power is one way that a larger portion of our electricity can be generated in a carbon neutral way while still providing sufficient electricity to meet demand (23). Moreover, the success or failure of the new nuclear reactors at Plant Vogtle may provide a lesson about the potential for nuclear power to provide viable solutions to the dilemma of maintaining, or even increasing, electricity generation while decreasing carbon dioxide emissions (5). We hypothesized that due to greater access to media and critical reading, the higher the education level, the less likely a participant would become susceptible to selection biased media. That is, how willing is the public to change their established opinions about nuclear power, based on exposure to a single news source intended to sway their opinions in one way or the other? Furthermore, how does the education level of the subject influence their susceptibility to this process? The higher the education level, the greater critical reading skills, allowing the reader to recognize the statement bias.

RESULTS

Study Design

Participants were asked to fill out a survey providing their level of agreement with ten statements related to the benefits and costs of nuclear power to society (pre-test) and then read one of two articles. The two articles used in this study were specifically selected because they present an obviously statement biased perspective either supporting nuclear power or opposing it. Of particular interest was whether the inherent statement bias in the articles would cause participants to question the credibility of the author of their assigned article as a trustworthy source of information. If the statement bias in the source caused participants to distrust the information they were consuming, their opinions in the pre-test and post-test should be extremely similar. If we can assume that more educated participants will have an increased awareness of the inherent statement bias, this type of critical analysis of the information and its source would cause a reduction in the impact of the news articles.

Figure 1. Results of a Repeated Measures Analysis of Variance (ANOVA) for time by treatment group interaction. .

Opinion Change Based On Article

To determine whether the changes in opinion among the respondents were significant, an ANOVA analysis was conducted to compare the six treatment groups across pre and post conditions. The six treatment groups were high school students who received the negatively statement biased article [HS (-)], high school students who received the positively statement biased article [HS (+)], college students who received the negatively statement biased article [Coll (-)], college students who received the positively statement biased article [Coll (+)], college graduates who received the negatively statement biased article [Grad (-)], and college graduates who received the positively statement biased article [Coll (+)].

HS (+), Coll (+), and Grad (+) groups showed a positive change in opinion from pre- to post-testing. In contrast, groups HS (-), Coll (-), and Grad (-) showed a negative change in opinion from pre- to post-testing (**Figure**

1, Table 1). To better understand the differences between the groups over time, the analysis indicated that there was not a significant difference between the six groups at pre-testing, $F(5, 145) = 1.56$ $p = 0.18$, $\eta^2_{partial} = 0.05$; there was, however, a significant difference between the groups at post-testing $F(5, 145) = 12.04$, $p < 0.001$, $\eta^2_{partial} = 0.29$ (**Table 2, Figure 1**). The main effect for time by itself was not significant $F(1, 145) = 2.38$, $p = 0.125$, $\eta^2_{partial} = 0.02$, but the main effect for treatment was significant $F(5, 145) = 4.08$, $\eta^2_{partial} = 0.12$. There is a significant interaction between time and treatment group, $F(5, 145) = 32.28$, $p < 0.001$, $\eta^2_{partial} = 0.53$, suggesting that the treatment groups are changing differently over time; because of the significant interaction, we focus on the interaction rather than the main effect for treatment group

ANOVA Analysis Education Level Differences

Post hoc tests indicated that the mean from the groups that received the negatively statement biased articles, HS (-), Coll (-), and Grad (-), were not statistically different from each other. They were, however, statistically different from the groups who received the positively statement biased article. Similarly, the mean from the groups that received the positively statement biased articles, HS (+), Coll (+), and Grad (+), were not statistically different from each other but were statistically different from the groups that received the negatively statement biased articles (**Figure 1, Table 2**).

	Group	Mean	Std. Deviation	N
Pre-test	HS (-)	32.90	8.02	21
	HS (+)	29.94	5.68	18
	Coll (-)	32.38	5.55	21
	Coll (+)	31	6.82	21
	Grad (-)	33.26	6.52	35
	Grad (+)	34.43	5.49	35
	Total	32.65	6.41	151
Post-test	HS (-)	29.1	8.91	21
	HS (+)	35.33	6.10	18
	Coll (-)	24.76	8.61	21
	Coll (+)	35.9	5.79	21
	Grad (-)	28.37	6.49	35
	Grad (+)	36.83	6.84	35
	Total	31.81	8.35	151

Table 1. Descriptive statistics by treatment group. Measures mean and standard deviation of each education level in pre-test and post-test. Total mean and standard deviation of all education levels is measured as well. N represents sample size.

The ANOVA analysis indicated that for groups HS (-), Coll (-), and Grad (-), the declines from pre-test to post-test were significant; the increases in scores from pre-test to post-test for groups HS (+), Coll (+), and Grad (+) were also all significant.

Two samples, students at a Georgia High School and a group of college students at Kennesaw State University display fluctuation in opinion change after reading a media article with often statement bias (**Figure 2, Figure 3**). The results of the survey for the college students did not appear to bear out the hypothesis that a higher level of education, and the corresponding expectation of stronger critical thinking skills, would result in a lower malleability of their opinions compared to the high school students (**Figure 4**).

(I) Group	(J) Group	Mean Difference (I-J)	Std. Error	p-value
HS (-)	HS (+)	-6.24*	2.29	.007
	Coll (-)	4.33	2.20	.051
	Coll (+)	-6.81*	2.20	.002
	Grad (-)	0.72	1.97	.714
	Grad (+)	-7.73*	1.97	.000
HS (+)	HS (-)	6.24*	2.29	.007
	Coll (-)	10.57*	2.29	.000
	Coll (+)	-0.57	2.29	.804
	Grad (-)	6.96*	2.07	.001
	Grad (+)	-1.5	2.07	.471
Coll (-)	HS (-)	-4.33	2.20	.051
	HS (+)	-10.571*	2.294	.000
	Coll (+)	-11.143*	2.204	.000
	Grad (-)	-3.610	1.971	.069
	Grad (+)	-12.067*	1.971	.000
Coll (+)	HS (-)	6.810*	2.204	.002
	HS (+)	0.571	2.294	.804
	Coll (-)	11.143*	2.204	.000
	Grad (-)	7.533*	1.971	.000
	Grad (+)	-0.924	1.971	.640
Grad (-)	HS (-)	-.724	1.971	.714
	HS (+)	-6.962*	2.071	.001
	Coll (-)	3.610	1.971	.069
	Coll (+)	-7.533*	1.971	.000
	Grad (+)	-8.457*	1.707	.000
Grad (+)	HS (-)	7.733*	1.971	.000
	HS (+)	1.495	2.071	.471
	Coll (-)	12.067*	1.971	.000
	Coll (+)	0.924	1.971	.640
	Grad (-)	8.457*	1.707	.000

Table 2. Post Hoc tests for the One-Way ANOVA at post-testing comparing the means of one group (I Group) to all other groups (J Groups). Measures mean, standard error, and p-value for each education level given a positive or negative article.

ANOVA tests conducted for analysis demonstrated that while the opinions of the 6 groups of respondents were not statistically different at the time of pre-testing, they had split into two clusters by the time of the post-test. The groups that received the positively statement biased article all showed a statistically significant increase in their overall opinion, and the groups that received the negatively statement biased article all showed a statistically significant decrease in their overall opinion (**Figure 1, Table 1, Table 2**).What is even more interesting is that the ANOVA tests revealed that there was no statistical difference in the overall opinion change at post-testing based on education level for the groups that received the same article. In summary, the respondents who received the positively statement biased article showed a similar change in their opinion regardless of whether they were high school students, college students, or college graduates. The same is true for the groups who received the

negatively statement biased article. This seems to disprove the initial hypothesis that an increase in education level would decrease the malleability of the respondents' opinions.

Survey Statement Trends

It is interesting that cost was the one specific issue that participants seem to link most closely to the overall value of nuclear power to society and its benefits to the future. Given previous studies that established a clear link between the positivity of people's opinions about nuclear power and safety concerns, it was surprising that the issue of cost seemed to be more important to our respondents than the issue of safety raised by Statement 2 "It is safe to live by nuclear facilities and reactors and Statement 10 "Nuclear power plants are unreliable" (4,6). This result may be due to the fact that one of the points of contention by the public concerning the new nuclear reactors being constructed in the state of Georgia

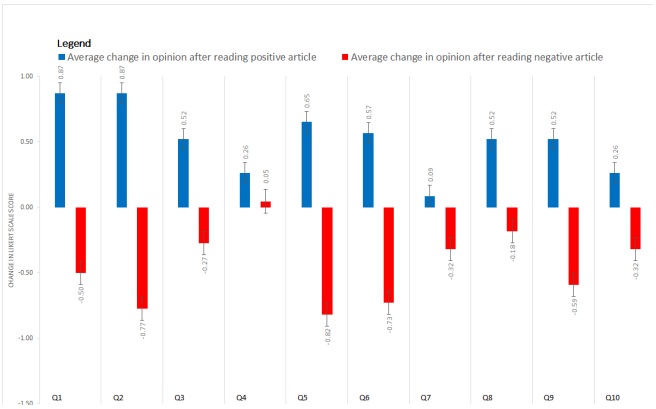

Figure 2. Positive article n=22. Negative Article n=22. Degree of opinion change for high school students after consumption of positive or negative popular media article about nuclear power. Values above or below each bar indicate the average change in opinion for each individual statement. The error bars represent standard error.

is the financial cost of the project, which the taxpayers are largely being asked to bear. This is especially frustrating to the public since cost overruns associated with the project have essentially doubled the cost of the project and delayed its completion by several years.

With the exception of Statement 4 "Many jobs have been created due to nuclear development" for high school students and Statement 8 "The U.S. should play a leading role in nuclear energy and safety standards" for college students and graduates, those who received the positively statement biased media article had a positive shift in their opinions, while those who received the negatively statement biased article had a negative shift in their opinions. While the degree of opinion change is generally lower in magnitude for college graduates than the results for the students, the changes in opinion that did occur were always in the direction of statement bias. It is also worth noting that there was no statistical difference in the opinions of the college graduates compared to the students who received the same kind of article. The opinions of college graduates after reading the negatively statement biased article were statistically equivalent to those of the high school and college students who read the same article, and the same was true for the graduates and students who read the positively statement biased article.

Regardless of education level, the clear presence of statement bias in the articles did not affect the participants' willingness to trust the information that they were being presented. It is also worth noting that the changes in opinion were greater than half a point in the Likert scale, which amounted to more than half a category, in most cases for both the high school and college students. Of the shifts in opinion recorded for high school students, 60% of them (12 out of 20) represent such a change. This trend was slightly higher for the participants who received the positive article (7 out of 10) than for those who received the negative article (5 out of 10). The college students showed a similar rate of change of opinion as the high school students (65% or 13 out of 20).

DISCUSSION

The participants who read the positive article showed more positive opinions about nuclear power, and vice versa for those who received the negatively statement biased article. Public opinion about nuclear power was generally quite malleable and susceptible to the influence of media statement bias. After reading a positively statement biased media article, respondents' opinions about nuclear power generally became more positive and vice versa for people who read a negatively statement biased media article. This was true across all levels of education surveyed.

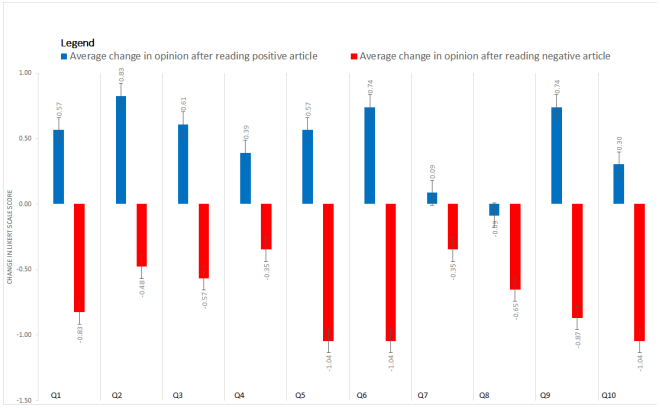

Figure 3. Positive article n=23. Negative Article n=23. Degree of opinion change for college students after consumption of positive or negative popular media article about nuclear power. Values above or below each bar indicate the average change in opinion for each individual statement. The error bars represent standard error.

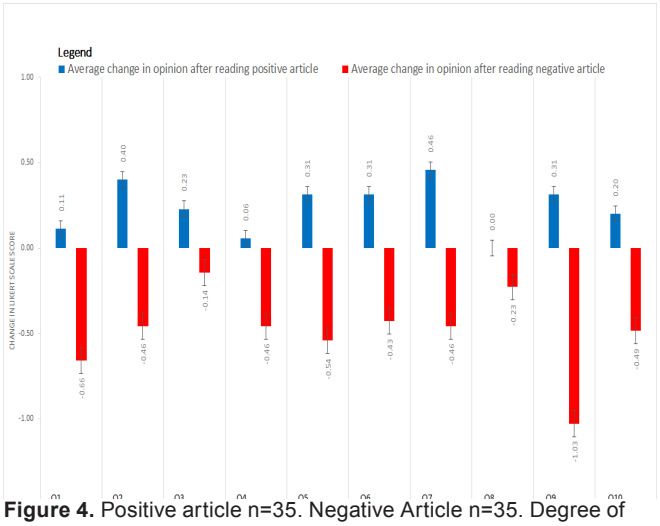

Figure 4. Positive article n=35. Negative Article n=35. Degree of opinion change for college graduates after consumption of positive or negative popular media article about nuclear power. Values above or below each bar indicate the average change in opinion for each individual statement.

Contrary to our initial hypothesis, a higher level of education did not result in a higher resistance to the media statement bias. College students and graduates showed a statistically similar level of susceptibility to statement bias, compared to high school students. All high school students in the study were at least 18 years of age, which may introduce some bias into the results. Not getting a representative sample of all high school students from 9th-12th grade may have skewed the results. The study also included college graduates (n=70) recruited either from teachers at the Georgia High School or graduates /instructors at KSU. This suggested that the college graduates were not any better able to identify media statement bias and limit its impact on their opinions than high school or college students.

Participants were not compensated for their time due to the nature of the study. The surveys for high school and college students were conducted in-person while the survey of college graduates was conducted online. This may also induce some bias in the results for the college graduates compared to the high school and college students.

The data suggests that high school students' opinions can become quite malleable and susceptible to modification after the consumption of a single media article about nuclear power. This seems to indicate that the inherent bias in the articles did not cause the college students to question the trustworthiness of the articles as a source of information either. Their opinions were just as malleable as those of the high school students. This is also reflected in the fact that, with the exception of Statement 8 "The U.S. should play a leading role in nuclear energy and safety standards", college students showed the same susceptibility to the influence of the media article statement bias.

Future studies could analyze the media's involvement in other environmental conflicts, such as genetically modified organisms, inorganic fertilizers, or microplastics, in order to investigate whether the same shift in opinion would occur if statement bias is present. A variety of controversial topics could be substituted in a repeated experiment. Another future study could use similar methods but include adults with doctorates as a group of participants, to test whether this highly educated sample has even greater resistance than college graduates. A sample containing only doctorates may be able to critically review the article presented to them more than those with lower levels of education. A participant with a doctorate may have seen more examples of statement media bias in their career. Moreover, a study could take place using middle school students and utilize basic language on energy in a survey. Most likely, the survey would have to be drastically different, but could uphold some of the same components from the original survey. Middle school students, who have learned earth and geological sciences, may lead to interesting fluctuation on nuclear opinions. Background on science and energy from classes may allow students to have a fascinating opinion on nuclear energy.

The statements most significantly impacted by the consumption of the statement biased media were 1 "Nuclear Energy is beneficial to society", 5 "Public money should be spent on nuclear reactors and facilities", and 9 "Nuclear energy is too expensive to be sustainable". Cost was a factor for which opinions remained malleable, even among college graduates. This shows that the concern most susceptible to media influence is cost and that people's opinions about this issue are correlated with their opinion of the overall benefit of nuclear power to society. The results of this study provide evidence that public opinion about nuclear power may be more open to change, with very little persuasion, than previously believed. Combatting climate change with alternative sources of energy, such as nuclear power, may emphasize nuclear energy's significant role both within the United States and within other countries to reduce carbon footprint.

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This is an issue facing not only the United States, but also many countries around the world (24, 25). The ability of popular media to change opinions on nuclear power is an important component to determine how public opinion will inform the discussion taking place within governments on how to solve this difficult quandary. This study displayed how people's opinions about nuclear power are more easily

swayed by popular media than one might expect and that higher levels of education do not seem to moderate this malleability to a significant degree.

METHODS

Survey Data Collection

In early 2017, participants were asked to fill out a survey providing their level of agreement with ten statements related to the benefits and costs of nuclear power to society (pre-test). College students and high school students took surveys with paper and pencil. College graduates took an online survey that was delivered through email to all faculty of KSU's College of Science and Math, teachers at the Georgia high school, and some KSU graduates. The online survey was developed using Qualtrics, a web-based survey application, and displayed in a web browser. IRB approval was obtained from the IRB board at KSU prior to initiating this study (IRB Approval #19-213).

Survey Design

For the purposes of measuring the change in their opinions, statements 1, 2, 4, 5, 6, and 8 were denoted as "positive" statements about nuclear power and statements 3, 7, 9, and 10 were considered "negative" statements about nuclear power. These negative statements had their results reverse coded for clarity. The ten statements in the survey were: 1. "Nuclear Energy is beneficial to society." (positive); 2. "It is safe to live by nuclear facilities and reactors." (positive); 3. "Public support for nuclear power has decreased in recent decades." (negative); 4. "Many jobs have been created due to nuclear development." (positive); 5. "Public money should be spent on nuclear reactors and facilities." (positive); 6. "More nuclear facilities should be built in the future." (positive); 7. "Nuclear energy is not a solution for climate change." (negative); 8. "The U.S. should play a leading role in nuclear energy and safety standards." (positive); 9. "Nuclear energy is too expensive to be sustainable." (negative); 10. "Nuclear power plants are unreliable." (negative).

Participants' responses were recorded using a standard Likert scale with five options: Strongly disagree, Disagree, Undecided, Agree, and Strongly Agree. Each response was translated into a numerical value with Strongly Disagree having a value of 1 and each subsequent response increasing in value by 1 with a maximum value of 5 for Strongly Agree. The pre-test took approximately 3 minutes to complete.

After completing the pre-test, participants were then asked to read a popular media article about nuclear power. Participants were given one of two potential articles, which took approximately 2-3 minutes to read. One article was "Top 10 reasons nuclear power will be the key to America's energy future", published in The Hill, an American political newspaper. This article presents a clear statement biased positive viewpoint of nuclear power. The other article was "10 Reasons to Oppose Nuclear Energy", published by Green America, a national not-for-profit organization. This article presents a clear negatively statement biased viewpoint of nuclear power. The article given to each participant was selected randomly.

After reading the assigned article, participants were asked to complete the same ten-statement survey a second time (post-test). The post-test took approximately 3 minutes to complete. Including time to read the articles, the surveys took around 10 minutes to administer.

Participant Selection

The study included high school students from a Georgia high school (n=45) and college students at Kennesaw State University (KSU) in Kennesaw, GA (n=46). All high school students had received at least 11 years of formal education. College students, though not explicitly surveyed for grade level, ranged from freshman to senior year based on class rosters. High school and college students were recruited based on the willingness of the instructor to provide class time to conduct the survey. The pool of college graduates (n=70) was recruited either from teachers at the Georgia high school or graduates/instructors at KSU. College graduates sampled were a mix of Bachelor, Master's, and Ph.D. degrees. Fewer than five participants did not complete the study. Participants who did not complete both parts of the survey were not included in the analyzed data.

Statistical Analyses

Data were analyzed using the SPSS software. For analysis of pre- and post-test scores, composite scores for all items were created and analyzed. Comparison of six respondent sets were analyzed for opinion fluctuation based on statement bias from the given articles. The groups consist of high school students who received the negatively statement biased article [HS(-)], high school students who received the positively statement biased article [HS (+)], college students who received the negatively statement biased article [Coll(-)], college students who received the positively statement biased article [Coll (+)], college graduates who received the negatively statement biased article [Grad (-)], and college graduates who received the positively statement biased article [Grad (+)].

The impact of the consumption of the popular media article on participants' opinions was measured by subtracting the point values between the responses from the pre-test and post-test. For example, if a participant reacted to the statement "Nuclear energy is beneficial to society" with the response "Disagree" (2 points) in the pre-test, but changed their response to "Strongly Agree" (5 points) in the post-test, the change in their opinion would be recorded as +3. However, if a participant responded to that statement with "Agree" (4 points) in the pre-test but changed their response to "Undecided" (3 points) in the post-test, the change in their opinion would be recorded as -1. Thus, the average impact of reading the positive or negative article on the participants' opinions about nuclear power can be gauged.

Composite scores were calculated for pre-testing as

well as for post-testing. For the survey, the coefficient alpha was 0.85 at pre-testing and 0.90 at post-testing. Skewness and kurtosis statistics (using a cutoff of absolute value of two) for each of the six treatment groups for pre- and post-test survey composite scores indicated the data met the assumption of normality. Mauchly's test of sphericity and Levene's test of homogeneity of variance suggested equal variances between and within groups ($p > 0.05$).

Significance is measured with ($p< 0.05$) and a Bonferroni correction and an adjusted cutoff alpha of 0.05/6 = 0.008 (**Table 2**).

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