**Perceptions of Nuclear Energy among University Students**

Andrew Elisalde・Andrew Ramirez

California State University Monterey Bay

**Abstract**

The perception of nuclear power has varied over the years. Currently, nuclear power is an important source of electricity because it does not rely on fossil fuels and hence produces no greenhouse gas emissions. However, current discussions are focusing on the dangers that surround nuclear energy. This is predominantly due to the recent earthquake and tsunami in Japan that caused the Fukushima disaster, as well as increased opposition in Germany and the United States. University students have great influence shaping the future politics of such issues, so it is imperative to know how students perceive nuclear power today. In this Capstone we conducted a survey between Americans and Japanese to analyze the knowledge of university students about nuclear power and how this affects their perceptions of the use of nuclear energy. Additionally, we would like to understand students’ perceptions of nuclear power as potential future energy source. We found that most students had basic knowledge about nuclear energy, but for more specialized knowledge the results were uneven. Many Americans knew that nuclear power plants can not explode like a bomb, but many Japanese students did not know that. Many Japanese were split on how they feel about the use of nuclear energy. Some felt positive, others felt negative. American students were mostly unsure. For future energy, both Americans and Japanese students agreed that environmental impact was most important.

**Introduction**

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1. **Significance of the Study**

Reducing carbon emissions has become a high priority in today’s society. Nuclear energy is a key component in accomplishing this goal. While studying abroad in Japan, many students seemed to hold a more neutral opinion of nuclear energy, despite the recent disaster in Fukushima. Americans tended to be more negative about nuclear energy, despite not experiencing any nuclear related incidents. This difference was very interesting and inspired us to do research about nuclear energy, how it is perceived in Japan and America, and what students think about using nuclear energy.

1. **Research Questions**

 1. How knowledgeable are students on how nuclear energy works?

 2. What are the perceptions of University students about the use of nuclear energy?

 3. What are students’ perceptions of potential future energy sources?

1. **Literature Review**

3.1. History of Nuclear Energy

In 1932, James Chadwick discovered the neutron, which led to the discovery of nuclear fusion. By 1946, developed countries began to research nuclear energy for commercial use. The first nuclear power plant to generate electricity opened in Russia in 1954 and by 1956 the first commercial nuclear power plant opened in England. In America, nuclear research began with the atom bomb, which was dropped on Hiroshima and Nagasaki, Japan in 1945. By 1946, peaceful applications for nuclear fusion was being developed. However, since nuclear energy's introduction to the American public, there had been strong opposition against its usage. By 1970, nuclear growth in the United States has stagnated. In Japan, nuclear energy research first began in 1955, and the first nuclear power plant opened in 1966. In 2002, Japan declared its future reliance on nuclear energy and signed a joint research agreement with the United States. Of the collaborative investigation with the United States. The 2011 tsunami and earthquake then caused the Fukushima nuclear disaster, which caused public support to nosedive.

3.2. Nuclear Energy Consumption & Consumption

In the United States, nuclear energy production accounts for 21% of total production, and is the third most produced energy source, the first being coal. In Japan, nuclear energy was the second most produced source before the Fukushima disaster, now producing only 5% in 2015. Now coal produces the most energy in Japan, followed closely by petroleum. Renewable energy produces 10% of total energy production. In the United States, petroleum is the most consumed energy source at 45%. Japan is the same, with 45% of its energy consumption also coming from petroleum. Before the Fukushima disaster, nuclear energy accounted for 13% of total energy consumption, now accounting for less than 1%.

1. **Research Method**

4.1 Research Question 1: How knowledgeable are students on how nuclear energy works?

 In regards to the question “Which raw material is used to generate energy at nuclear power stations?” most American and Japanese students were able to answer correctly. (Shown in figure 1) Next we asked “Nuclear power plants are often associated with giant cooling towers. What do these towers emit?” About 30% of American students chose “water vapor” while the two most chosen answers for Japanese students were “water vapor” and “radiation”. More than half of the Japanese students did not choose the correct answer. (Shown in figure 2)

 Figure 1 Figure 2

As seen in figure 3, roughly half of all American students correctly chose that a nuclear reactor cannot explode like a nuclear weapon. However, only 9% of all Japanese respondents thought it was impossible. Many Japanese students seem to think that a nuclear reactor can explode like a nuclear weapon, possibly influenced by the Fukushima disaster.

 Figure 3

Regarding the question "How many nuclear power plants are currently operating in your country", Japanese students were much more aware than American students. 30% of Japanese students knew the approximate number of nuclear power plants in their country. A majority of American students did not have much knowledge on the matter with only 9% answering correctly. (Shown in figure 4)

Figure 4

The next part of the quiz tested nuclear waste knowledge. For the question “I think that nuclear waste is at high risk of leaking into the environment”, 67% of Americans and 82% of Japanese believe that nuclear waste is at high risk of leaking into the environment. Also, for the question “What is the composition of most high-level nuclear waste?” metal is the correct answer, but neither American nor Japanese students were able to answer correctly. (Seen in figure 5)

Figure 5

 In summary for our first research question we found that American and Japanese students both had low levels of knowledge in terms of nuclear waste. In spite of the Fukushima nuclear disaster being the second most serious nuclear accident in the world, there are many people who do not have correct knowledge about nuclear energy. It appears that many students had preconceptions about nuclear energy. For instance there was misconceptions in thinking that nuclear waste was a plasma, or the incorrect thought that a nuclear power plant can explode like a nuclear weapon.

4.2. Research Question 2: What are the perceptions of university students about the use of nuclear energy?

 Although opinions about the use of nuclear energy varied, Japanese students tended to be more negative. Students who answered questions in the quiz portion correctly tended to be more positive towards nuclear energy. In figure 6 "How do you feel about the current use of nuclear energy in your country?", Japanese students were very likely to have an opinion one way or the other, with 47% feeling negative and 41% feeling positive. Only 12% of Japanese students picked "don't know". On the other hand, 38% of American students felt positive, 26% felt negative, and 35% answered "don't know".

Figure 6

In order to gain a better idea of student opinion about future energy demand, we asked “In the next decade, I think my country’s nuclear energy demand will…” 70% American students chose that nuclear energy demand will increase while 17% answered that demand will decrease. Also, 50% of Japanese students predict that nuclear demand will increase, while 29% predict that demand will decrease (Seen in figure 7).

Figure 7

In relation to figure 8 "I think nuclear accidents are a common occurrence", a majority of students thought that nuclear related accidents are not very common. More than half of all Japanese students disagreed with the statement, with a similar number of American students believing the same. Only 20% of all students thought that they were common occurrences.

Figure 8

The next portion of our survey was how do university students in Japan and the United States think about government policies? In response to the question “I feel that government policies on nuclear energy keep me safe”, 47% of Americans answered “unsure” while 76% do not agree (Seen in figure 9).

 Figure 9

In summary for research question 2, the data shows that opinions varied between Japanese and American students. The Japanese students tended to view nuclear energy more negatively than Americans. However, those who did well on the quiz portion tended to do think more favorably of nuclear energy. In that respect, knowledge of nuclear energy seems to be directly connected with opinions of nuclear energy. Influence of the Fukushima nuclear disaster was a possible reason for Japanese students feeling more negative, while Americans did feel strongly either way. It is possible Americans do not hold strong opinions because a large nuclear accident has not occurred in the United States since 1979.

4.3. Research Question 3: What are students’ perceptions of potential future energy sources?

 Concerning the question about whether nuclear energy can lead to the reduction of CO2 emissions, almost half of all Japanese students think that nuclear energy will reduce carbon emissions. 44% of Americans also think that nuclear energy can reduce carbon dioxide. (Seen on figure 10)

 Figure 10

Next, we asked about how students felt about the construction and reactivation of nuclear power plants. For the questions “We should build more nuclear power plants in the future” and “We should restart nuclear reactors that have been deactivated” we found that 41% of all students are opposed to building new nuclear power plants, and 60% of all students were opposed to reactivating power plants that are currently not running. (Shown on figure 11 and 12)

 Figure 11 Figure 12

The next result is in relation to figures 13 and 14 “Renewable sources should take priority over nuclear energy” and "Other renewable sources have more potential than nuclear energy". For these research questions, Japanese and American students believed that renewable options have more potential than nuclear energy. If given the option, both American and Japanese students would prefer that renewable energy take priority over nuclear energy.

 Figure 13 Figure 14

 As seen in figure 15, the question asks “What will your country’s main source for electricity be 10 years from now?” 58% of both groups of students chose a renewable energy source as the expected main source of energy. Also, solar power was overwhelmingly the most popular prediction as the main power source in a decade.

Figure 15

 In summary for our third research question, we found that many social factors were found to affect students’ opinions of nuclear energy. For instance, students who live in a country with a recent nuclear accident have strong opinions about the topic. American students do not really have a fear of nuclear energy, so opinions for them tended to vary. It is likely due to the fact that they have not had to experience a nuclear accident like Japan.

1. **Conclusion**

In conclusion, we found that many factors influence the perception of nuclear energy such as country, recent disasters, and popular opinion of the country in question. Stereotypes also play a significant role when considering nuclear energy. Recurring themes of leaking radiation, liquid waste, and other harmful effects were prevalent in this survey. Japanese students were more negative about nuclear energy, possibly influenced by the 2011 Fukushima Daiichi disaster. Americans were less concerned and opinions varied; American students have not experienced a nuclear disaster. Awareness about nuclear energy can directly affect perceptions; students that did well on the quiz tended to be positive about nuclear energy. Students also see nuclear energy as an effective way to lower CO2 emissions, but few would prefer this over renewable sources, given the choice. This project has made us realize the importance of raising awareness about nuclear energy on campus. It is important to be proactive learning about nuclear energy and not wait for an accident to happen. We also learned the importance of using all energy sources. Students should understand that no single energy source is the answer to our needs.

1. **Limitations of the Study**

 This data was taken mostly from CSUMB and the University of Shiga University students so it’s difficult to generalize these results for the results of their perspective countries. Also the ratio of men to women that our survey is skewed towards women. In the future we would like to gather the opinions of college professors and see if there is a correlation of their opinions and the opinions of their students.

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