Technology Teachers' Attitudes toward Nuclear Energy and Their Implications for Technology Education

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Abstract

The purpose of this paper was to explore high-school (grades 10-12) technology teachers' attitudes toward nuclear energy and their implications to technology education. A questionnaire was developed to solicit 323 high-school technology teachers' responses in June 2013 and 132 (or 41%) valid questionnaires returned. Consequently, the following five conclusions can be made: (1) Most high-school technology teachers in Taiwan are keen on news about Japan's Fukushima nuclear disaster. (2) The majority of high-school technology teachers oppose more nuclear power plants in Taiwan, are now "less supportive of expanding nuclear power plants in Taiwan after Japan's Fukushima nuclear disaster, oppose to extend the operating lifespan of the operating nuclear power plants in Taiwan, and oppose the construction of a new nuclear reactor within 80 kilometers of their homes. (3) The majority of technology teachers in Taiwan are now more supportive than they were before Japan's Fukushima nuclear disaster of using clean renewable energy resources – such as wind and solar – and increased energy efficiency as an alternative to more nuclear power in Taiwan, and support a termination or moratorium on new nuclear power plant construction in Taiwan if increased energy efficiency and off the shelf renewable technologies such as wind and solar could meet our energy demands for the near term. (4) Nearly a half of high-school technology teachers in Taiwan do not know the evacuation route and what other steps to take in the event of the nearest nuclear power plant emergency. (5) The majority of high-school technology teachers in Taiwan includes nuclear energy in their technology courses, and will enrich nuclear energy in their technology courses.

Keywords: nuclear energy, nuclear waste, technology education, technological issue

BACKGROUND AND PURPOSE

We are pursuing sustainable energy sources that are available to supply the world's expanding needs without detriment to our future generations. Although considered as a low carbon power generation source, nuclear energy has been the subject of debate because its radioactive wastes remain a major issue and its safety becomes a global concern. Since the world's first nuclear power plant was set up in 1954, the three worst nuclear disasters occurred as follows: Three Mile Island in the United States, 1979, Chernobyl in the former Soviet Union, 1986 and Fukushima in Japan, 2011. This history unfolds that the nature of nuclear energy could be unsafe and unethical. However, Kubota (2012) examined public attitudes toward nuclear energy after the Fukushima nuclear accident and reveals that the need for the efficient production of nuclear power outweighs concern for the potential danger of a nuclear incident.

Taiwan imports 99% of its energy and nuclear power has been a significant part (about 20%) of the electricity supply. There are three operating nuclear power plants with six reactors and the fourth one with two reactors is under construction in Taiwan. Taiwan authorities argue that nuclear power is considerably cheaper than alternatives. However, due to Japan's Fukushima nuclear disaster, the anti-nuclear movement has grown and the public (or technological) issue in favor of or against nuclear power has become controversial in Taiwan.

Energy and Power, including nuclear energy, is a content area of the official high-school technology education curriculum in Taiwan. One of the goals of technology education in Taiwan is to facilitate students in dealing with technological issues critically and intellectually. Social psychologists' attitude-behavior consistency theory argues that our attitudes (predispositions to behavior) and actual behaviors are more likely to align if our attitude and behavior are both constrained to very specific circumstances (Changing Minds, u.d.). Accordingly, technology teacher's attitudes influence what students are taught and how they are taught. An exploration of technology teachers' attitudes toward nuclear energy can help technology teachers understand their own as well as their peer's attitudes and to further develop curriculum and instruction. Thus, the purpose of this paper was to explore high-school technology teachers' attitudes toward nuclear energy and their implications to technology education.

METHOD AND PROCEDURE

In order to attain the purpose, a questionnaire survey was conducted. We administered a survey using a questionnaire modified from the ORC International (2011) and distributed it to all 323 high schools offering technology education courses.

In June 2013, the modified questionnaire was sent to the Director of Academic Affairs of each school who was asked to pass over the questionnaire to a technology teacher. Technology teachers directly sent back the questionnaire when they complete it. As a result, 132 (or 41%) valid questionnaires were obtained.

In addition to descriptive statistical analyses, the inferential statistical analysis, Pearson's Chi-square test, was employed to test how likely it is that the questionnaire respondent's answer and his/her gender, school as well as location affiliation, respectively, are completely independent.

FINDINGS AND CONCLUSIONS

As shown in Appendix, in the 30 Chi-square tests, only three Chi-square values are statistically significant. This indicates that there are few significant differences between the gender, school, and location affiliation among our samples. Hence, the findings of this survey can be highlighted as follows:

1. 97% of technology teachers are "following news about Japan's Fukushima nuclear disaster."
2. 61% of technology teachers oppose more nuclear power plants in Taiwan.
3. 70% of technology teachers are now "less supportive of expanding nuclear power plants in Taiwan after Japan's Fukushima nuclear disaster."
4. 79% of technology teachers say they are now "more supportive than they were before Japan's Fukushima nuclear disaster in using clean renewable energy resources – such as wind and solar – and increasing energy efficiency as an alternative to more nuclear power in Taiwan."
5. 71% of technology teachers support a termination or moratorium on new nuclear power plant construction in Taiwan if increased energy efficiency and existing renewable technologies such as wind and solar could meet our energy demands for the near term.
6. 66% of technology teachers oppose to extend the operating lifespan of the operating nuclear power plants in Taiwan.
7. 85% of technology teachers oppose the construction of a new nuclear reactor within 80 kilometers of their homes.
8. 46% of technology teachers do not know the evacuation route and what other steps to take in the event of the nearest nuclear power plant emergency.
9. 61% of technology teachers include nuclear energy in their technology courses.
10. 65% of technology teachers will enrich nuclear energy in their technology courses.

Based on the above findings, the high-school technology teachers prefer increasing energy efficiency and existing renewable technologies to constructing more nuclear power plants or extending the operating lifespan of the operating

nuclear power plants. They also consider a nuclear plant as a NIMBY (Not In My Back Yard) object. In addition, they intend to include more nuclear energy issues in their technology education courses. According to the attitude–behavior consistency theory that attitudes can predict behavior, against nuclear power will be stronger than in favor of nuclear power in the circumstance of high-school technology education in Taiwan.

Based upon the above findings and discussions, the following conclusions can be drawn:

1. Most high-school technology teachers in Taiwan are keen on news about Japan's Fukushima nuclear disaster.
2. The majority of high-school technology teachers oppose more nuclear power plants in Taiwan, are now "less supportive of expanding nuclear power plants in Taiwan after Japan's Fukushima nuclear disaster, oppose to extend the operating lifespan of the operating nuclear power plants in Taiwan, and oppose the construction of a new nuclear reactor within 80 kilometers of their homes.
3. The majority of technology teachers in Taiwan are now more supportive than they were before Japan's Fukushima nuclear disaster to use clean renewable energy resources – such as wind and solar – and increased energy efficiency as an alternative to more nuclear power in Taiwan, and support a termination or moratorium on new nuclear power plant construction in Taiwan if increased energy efficiency and off the shelf renewable technologies such as wind and solar could meet our energy demands for the near term.
4. Nearly a half of high-school technology teachers in Taiwan do not know the evacuation route and what other steps to take in the event of the nearest nuclear power plant emergency.
5. The majority of high-school technology teachers in Taiwan includes nuclear energy in their technology courses, and will enrich nuclear energy in their technology courses.

IMPLICATIONS

Based on the above conclusions, the implications of teachers' attitudes toward nuclear energy to technology education can be made as follows:

1. Training and development opportunities, such as workshop and discussion forum, should be offered.

   Being keen on news about nuclear energy is not enough. To ensure technology teachers' knowledge regarding nuclear energy is updated and accurate, appropriate training and development opportunities should be offered.
2. Best practices of nuclear energy education should be identified and benchmarked

   The majority of technology courses have included nuclear energy. Best practices

of nuclear energy education should be identified among them for further promotion.

3. Both energy saving and development should be valued in high-school technology courses.

   That is to say, the strategies and possibilities to increase energy efficiency and develop clean renewable energy resources should taught in high-school technology courses. However, to high-school student increasing energy efficiency has higher priority than the development of new energy resources.

4. A debate can be served as a strategy for high-school students to clarify the controversial issue of nuclear energy.

   To help high-school students to become informed critical thinkers and decision makers, technology teachers can adopt a debate as an instructional strategy. In addition, the debate activity can be collaboratively conducted with other subjects, such as sciences, moral education, and so on.

References

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Appendix: The contingency table of Chi-square analyses

Question	Answer	Total	a. Gender		b. School		c. Location--Living within 80 kilometers of a nuclear power plant site?		
			Male	Female	Pubic	Private	Yes	No	Don't Know/ Not sure
1. How closely are you following news about Japan's Fukushima nuclear disaster?	Very closely	22 (16.7%)	16 (72.7%)	6 (27.3%)	17 (77.3%)	5 (22.7%)	5 (22.7%)	16 (72.7%)	1 (4.5%)
	Somewhat closely	82 (62.1%)	66 (80.5%	16 (19.5%)	43 (52.4%)	39 (47.6%)	14 (17.1%)	65 (79.3%)	3 (3.7%)
	Not very closely	25 (18.9%)	19 (76.0%)	6 (24.0%)	18 (72.0%)	7 (28.0%)	3 (12.0%)	20 (80.0%)	2 (8.0%)
	Not following it	3 (2.3%)	1 (33.3%)	2 (66.7%)	3 (100.0%)	0 (0.0%)	0 (0.0%)	2 (66.7%)	1 (33.3%)
	Don't know/Not sure	0 (0.0%	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)
	Total	132 (100%)	102 (77.3%)	30 (22.7%)	81 (61.4%)	21 (38.6%)	22 (16.7%)	103 (78.0%)	7 (5.3%)
	a. $\chi^2(4)$ =4.063								
	b. $\chi^2(4)$ =8.185								
	c. $\chi^2(8)$ =6.707								
2. Would you say that you support or oppose more nuclear power plants in Taiwan?	Support strongly	6 (4.5%)	6 (100.0%)	0 (0.0%)	2 (33.3%)	4 (66.7%)	2 (33.3%)	4 (66.7%)	0 (0.0%)
	Support somewhat	30 (22.7%)	25 (83.3%)	5 (16.7%)	17 (56.7%)	13 (43.3%)	5 (16.7%)	23 (76.7%)	2 (6.7%)
	Oppose somewhat	35 (26.5 %)	27 (77.1%)	8 (22.9%)	21 (60.0%)	14 (40.0%)	4 (11.4%)	28 (80.0%)	3 (8.6%)
	Oppose strongly	46 (34.8%)	36 (78.3%)	10 (21.7%)	28 (60.9%)	18 (39.1%)	9 (19.6%)	36 (78.3%)	1 (2.2%)
	Don't know/Not sure	15 (11.4%)	8 (53.3%)	7 (46.7%)	13 (86.7%)	2 (13.3%)	2 (13.3%)	12 (80.0%)	1 (6.7%)
	Total	132 (100%)	102 (77.3%)	30 (22.7%)	81 (61.4%)	51 (38.6%)	22 (16.7%)	103 (78.0%)	7 (5.3%)
	a. $\chi^2(4)$ =7.313								
	b. $\chi^2(4)$ =6.350								
	c. $\chi^2(8)$ =4.070								
3. Are you now more or less supportive of expanding nuclear power plants in Taiwan after Japan's Fukushima nuclear disaster?	Much more supportive	3 (2.3%)	2 (66.7%)	1 (33.3%)	2 (66.7%)	1 (33.3%)	0 (0.0%)	3 (100.0%)	0 (0.0%)
	Somewhat more supportive	5 (3.8%)	4 (80.0%)	1 (20.0%)	1 (20.0%)	4 (80.0%)	1 (20.0%)	3 (60.0%)	1 (20.0%)
	Somewhat less supportive	38 (28.8%)	29 (76.3%)	9 (23.7%)	25 (65.8%)	13 (34.2%)	6 (15.8%)	30 (78.9%)	2 (5.3%)
	Much less supportive	54 (40.9%)	41 (75.9%)	13 (24.1%)	33 (61.1%)	21 (38.9%)	10 (18.5%)	43 (79.6%)	1 (1.9%)
	No change	28 (21.2%)	25 (89.3%)	3 (10.7%)	16 (57.1%)	12 (42.9%)	5 (17.9%)	21 (75.0%)	2 (7.1%)
	Don't know/Not sure	4 (3%)	1 (25.0%)	3 (75.0%)	4 (100.0%)	0 (0.0%)	0 (0.0%)	3 (75.0%)	1 (25.0%)
	Total	132 (100%)	102 (77.3%)	30 (22.7%)	81 (61.4%)	51 (38.6%)	22 (16.7%)	103 (78.0%)	7 (5.3%)
	a. $\chi^2(5)$ =8.813								
	b. $\chi^2(5)$ =6.688								
	c. $\chi^2(10)$ =8.320								

Question	Answer	Total	a. Gender		b. School		c. Location--Living within 80 kilometers of a nuclear power plant site?		
			Male	Female	Pubic	Private	Yes	No	Don't Know/ Not sure
4. Would you say that you are now more or less than you were before Japan's Fukushima nuclear disaster in using clean renewable energy resources – such as wind and solar – and increasing energy efficiency as an alternative to more nuclear power in Taiwan?	Much more suppor -tive	50 (37.9%)	40 (80.0%)	10 (20.0%)	31 (62.0%)	19 (38.0%)	10 (20.0%)	39 (78.0%)	1 (2.0%)
	Somewhat more suppor -tive	54 (40.9%)	39 (72.2%)	15 (27.8%)	32 (59.3%)	22 (40.7%)	9 (16.7%)	41 (75.9%)	4 (7.4%)
	Somewhat less suppor -tive	4 (3%)	4 (100.0%)	0 (0.0%)	2 (50.0%)	2 (50.0%)	0 (0.0%)	3 (75.0%)	1 (25.0%)
	Much less suppor -tive	1 (0.8%)	0 (0.0%)	1 (100.0%)	0 (0.0%)	1 (100.0%)	0 (0.0%)	1 (100.0%)	0 (0.0%)
	No change	22 (16.7%)	19 (86.4%)	3 (13.6%)	15 (68.2%)	7 (31.8%)	3 (13.6%)	19 (86.4%)	0 (0.0%)
	Don't know/Not sure	1 (0.8%)	0 (0.0%)	1 (100.0%)	1 (100.0%)	0 (0.0%)	0 (0.0%)	0 (0.0%)	1 (100.0%)
	Total	132 (100%)	102 (77.3%)	30 (22.7%)	81 (61.4%)	51 (38.6%)	22 (16.7%)	103 (78.0%)	7 (5.3%)
	a. $\chi^2(5)$ =10.008								
	b. $\chi^2(5)$ =2.977								
	c. $\chi^2(10)$ =25.064								
5. If increased energy efficiency and existing renewable technologies such as wind and solar could meet our energy demands for the near term, would you support a termination or moratorium on new nuclear power plant construction in Taiwan?	Yes	93 (70.5%)	71 (76.3%)	22 (23.7%)	61 (65.6%)	32 (34.4%)	16 (17.2%)	75 (80.6%)	2 (2.2%)
	No	20 (15.2%)	17 (85.0%)	3 (15.0%)	6 (30.0%)	14 (70.0%)	4 (20.0%)	14 (70.0%)	2 (10.0%)
	Don't know/Not sure	19 (14.4%)	14 (73.7%)	5 (26.3%)	14 (73.7%)	5 (26.3%)	2 (10.5%)	14 (73.7%)	3 (15.8%)
	Total	132 (100%)	102 (77.3%)	30 (22.7%)	81 (61.4%)	51 (38.6%)	22 (16.7%)	103 (78.0%)	7 (5.3%)
	a. $\chi^2(2)$ =0.865								
	b. $\chi^2(2)$ =10.216								
	c. $\chi^2(4)$ = 7.387								

Question	Answer	Total	a. Gender		b. School		c. Location--Living within 80 kilometers of a nuclear power plant site?		
			Male	Female	Pubic	Private	Yes	No	Don't Know/ Not sure
6.Would you support or oppose to extend the operating lifespan of the operating nuclear power plants in Taiwan?	Support strongly	2 (1.5%)	2 (100.0%)	0 (0.0%)	0 (0.0%)	2 (100.0%)	0 (0.0%)	2 (100.0%)	0 (0.0%)
	Support some -what	31 (23.5%)	24 (77.4%)	7 (22.6%)	14 (45.2%)	17 (54.8%)	6 (19.4%)	24 (77.4%)	1 (3.2%)
	Oppose some -what	40 (30.3%)	27 (67.5%)	13 (32.5%)	24 (60.0%)	16 (40.0%)	6 (15.0%)	30 (75.0%)	4 (10.0%)
	Oppose strongly	47 (35.6%)	40 (85.1%)	7 (14.9%)	34 (72.3%)	13 (27.7%)	8 (17.0%)	38 (80.9%)	1 (2.1%)
	Don't know/Not sure	12 (9.1%)	9 (75.0%)	3 (25.0%)	9 (75.0%)	3 (25.0%)	2 (16.7%)	9 (75.0%)	1 (8.3%)
	Total	132 (100%)	102 (77.3%)	30 (22.7%)	81 (61.4%)	51 (38.6%)	22 (16.7%)	103 (78.0%)	7 (5.3%)
	a. $\chi^2(4)$ =4.442								
	b. $\chi^2(4)$ =9.970*								
	c. $\chi^2(8)$ = 3.896								
7.Would you support or oppose the construction of a new nuclear reactor within 80 kilometers of your home?	Support strongly	5 (3.8%)	5 (100.0%)	0 (0.0%)	3 (60.0%)	2 (40.0%)	3 (60.0%)	2 (40.0%)	0 (0.0%)
	Support some -what	7 (5.3%)	6 (85.7%)	1 (14.3%)	3 (42.9%)	4 (57.1%)	1 (14.3%)	6 (85.7%)	0 (0.0%)
	Oppose some -what	28 (21.2%)	23 (82.1%)	5 (17.9%)	17 (60.7%)	11 (39.3%)	7 (25.0%)	17 (60.7%)	4 (14.3%)
	Oppose strongly	84 (63.6%)	61 (72.6%)	23 (27.4%)	52 (61.9%)	32 (38.1%)	9 (10.7%)	73 (86.9%)	2 (2.4%)
	Don't know/Not sure	8 (6.1%)	7 (87.5%)	1 (12.5%)	6 (75.0%)	2 (25.0%)	2 (25.0%)	5 (62.5%)	1 (12.5%)
	Total	132 (100%)	102 (77.3%)	30 (22.7%)	81 (61.4%)	51 (38.6%)	2 (16.7%)	103 (78.0%)	7 (5.3%)
	a. $\chi^2(4)$ =3.645								
	b. $\chi^2(4)$ =1.659								
	c. $\chi^2(8)$ =19.124*								
8.Do you know the evacuation route and what other steps to take in the event of the nearest nuclear power plant emergency?	Yes	34 (25.8%)	24 (70.6%)	10 (29.4%)	20 (58.8%)	14 (41.2%)	9 (26.5%)	23 (67.6%)	2 (5.9%)
	No	61 (46.2%)	47 (77.0%)	14 (23.0%)	36 (59.0%)	25 (41.0%)	9 (14.8%)	49 (80.3%)	3 (4.9%)
	Don't know/Not sure	37 (28%)	31 (83.8%)	6 (16.2%)	25 (67.6%)	12 (32.4%)	4 (10.8%)	31 (83.8%)	2 (5.4%)
	Total	132 (100%)	102 (77.3%)	30 (22.7%)	81 (61.4%)	51 (38.6%)	22 (16.7%)	103 (78.0%)	7 (5.3%)
	a. $\chi^2(2)$ =1.760								
	b. $\chi^2(2)$ =0.835								
	c. $\chi^2(4)$ =19.124*								

Question	Answer	Total	a. Gender		b. School		c. Location—Living within 80 kilometers of a nuclear power plant site?		
			Male	Female	Pubic	Private	Yes	No	Don't Know/ Not sure
9. Do you include nuclear energy in your technology courses?	Yes	80 (60.6%)	61 (76.3%)	19 (23.8%)	50 (62.5%)	30 (37.5%)	15 (18.8%)	62 (77.5%)	3 (3.8%)
	No	46 (34.8%)	35 (76.1%)	11 (23.9%)	28 (60.9%)	18 (39.1%)	7 (15.2%)	36 (78.3%)	3 (6.5%)
	Don't know/Not sure	6 (4.5%)	6 (100.0%)	0 (0.0%)	3 (50.0%)	3 (50.0%)	0 (0.0%)	5 (83.3%)	1 (16.7%)
	Total	132 (100%)	102 (77.3%)	30 (22.7%)	81 (61.4%)	51 (38.6%)	22 (16.7%)	103 (78.0%)	7 (5.3%)
	a. $\chi^2(2)$ =1.849								
	b. $\chi^2(2)$ =0.375								
	c. $\chi^2(4)$ =3.245								
10. Will you enrich nuclear energy in your technology courses?	Yes	86 (65.2%)	66 (76.7%)	20 (23.3%)	51 (59.3%)	35 (40.7%)	14 (16.3%)	69 (80.2%)	3 (3.5%)
	No	18 (13.6%)	15 (83.3%)	3 (16.7%)	10 (55.6%)	8 (44.4%)	4 (22.2%)	13 (72.2%)	1 (5.6%)
	Don't know/Not sure	28 (21.2%)	21 (75.0%)	7 (25.0%)	20 (71.4%)	8 (28.6%)	4 (14.3%)	21 (75.0%)	3 (10.7%)
	Total	132 (100%)	102 (77.3%)	30 (22.7%)	81 (61.4%)	51 (38.6%)	22 (16.7%)	103 (78.0%)	7 (5.3%)
	a. $\chi^2(2)$ =0.473								
	b. $\chi^2(2)$ =1.607								
	c. $\chi^2(4)$ =2.683								

*p<.05