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Pre-Service Teachers' Perception on Radiation and Radiation Risk

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Abstract: This study investigated the perception of pre-service teachers on radiation and radiation risk exposure. About 200 university students in their second year, taking up Bachelor in Elementary Education took part of this study. It made use of an adopted questionnaire on perception of radiation risk coupled with content-validated researcher-developed questions. Data gathering took place at a time when these students were taking a course in physics in health sciences. Findings from the survey revealed a satisfactory perception of radiation and radiation risk, but individual interviews revealed existing gaps in the knowledge and understanding of these themes. Terminologies, events, and instances that is frequently associated with radiation were also explored.

Keywords: radiation, radiation risk, perception, pre-service teachers

Introduction

Radiation and radiation risk perception was found to influence various aspects and sectors of society. In medical practice, patients' decision against undergoing radiation-related tests and treatments were usually based on partial or incorrect information about radiation risk (Broadbent and Hubbard, 1992; Freudenberg and Beyer, 2011). Similarly, in a bigger scale and extreme scenario, psychological stress were frequent in people who have partial or alternative perception on the health effects of radiation exposure (Suzuki, 2015). Hence, studies on radiation and radiation risk perceptions were conducted in various contexts to sort out the factors affecting these perceptions and to find its implications accordingly.

It was revealed that there is no uniform and consistent perception of radiation risk (Slovic, 1996). A number of factors have been identified to explain this wide array of perceptions. Similar to general risk analysis, radiation risk perception was initially anchored to cultural theory and psychometric model (Sjoberg, 2000). However, recent studies identified more and more factors, in that the scope of these theories were already limited and not enough (Sjoberg, 2000). In recent times, societal and ethical factors were among the considerations and inclusions in risk perception (Oughton, 2016).

Along this line, three studies have been conducted a decade apart, revealing that risk perception depend on the context of radiation applications, uses, and exposures (Eijkelhof, Klaassen and Lijnse, 1989; Slovic, 1996; Freudenstein, Wiedemann and Varsier, 2015). Moreover, publicity (Eijkelhof, Klaassen and Lijnse, 1989), individuals' characteristics (Brenot, 1992), and knowledge about radiation risks (Freudenstein, Wiedemann and Varsier, 2015) affect radiation risk perception. Moreover, it was also suggested that radiation risk perception maybe due to educational background (Itaki et al, 2012). Further, gender was also found to affect radiation risk perception, in that, females showed more concern than males especially along issues related to health effects of radiation (Morioka, 2015).

As proven by these studies, knowledge and awareness on radiation and radiation risk is significantly important on radiation risk perception. However, even in the past, it was found that there is lack of information regarding radiation and radiation risk (Boggs-Mayes, 1989). Most knowledge and information about these concepts are usually learned from school or the television (Tomisawa et al, 2012). At present, the mass media plays a big role in increasing awareness of radiation and radiation risk, but a study revealed that mass media do not use the same language as experts do towards addressing radiation risk (Perko, 2014). Hence, it may result to disagreement between experts and the public as a whole (Sjoberg, 1999). Generally, experts' perception on radiation risk is better than the general population (Stievenart and Turcanu, 2013). However, this was not the case in the work of Perko (2014). He reported that at times, public perception may be better than the experts. This is proven when he reported that public's perception is better regarding the use of nuclear power plants and exposure to nuclear wastes.

Studies have also shown that partial radiation risk perception was due to poor mental health (Norris, Friedman and Watson, 2002; Adams et al, 2011; Bromet, 2014) specifically along the incorrect understanding of health effects of radiation and radiation exposure (Kim et al, 2011). Wrong understanding resulted to greater risk perception (Southwood, 1994) and better knowledge showed low concernedness as proven by the lower radiation anxiety level of professionals dealing with radiation (Miha, 2003).

In a bigger scale, a number of cross-country and cross-cultural survey related to radiation and radiation risk perception have been done (Brenot, 1996; Leong, 2014). Notable findings were observed from these surveys. In the work of Leong (2014) from three Northeast Asian countries, it was found that majority of the respondents manifested their intent to do away with nuclear power plants and recognized cancer as the immediate effect of radiation exposure.

Studies were also conducted to find out the existing gap in understanding radiation and radiation risk. Even practitioners, knowledge and awareness on radiation hazard was found to be inadequate (Salih, 2014). One example may be the physicians' lack of knowledge on radiation levels associated with nuclear medicine and radiation-related medical tests (Freudenberg, 2011). Another was the general public who have been using radiation-related technologies and exposed to radiation-related medical tests and treatments showing a significantly insufficient knowledge on radiation protection (Yucel et al, 2009; Hassoy, Durosoy, Karababa, 2013).

In addition, studies on radiation and radiation risk perception were also conducted in schools. It was reported that university students specifically those who are enrolled in health or medical related degree programs associated radiation to x-rays, CT photogram, Mister and Madam Curie and Chernobyl (Itaki et al, 2012). Moreover, it was found that understanding of radiation and radiation risk increases with increasing year level in the university but radiation risk perception remained unchanged (Tomisawa et al, 2012). Further, it was found that through careful teaching, fear, difficulty and interest towards radiation and radiation risk maybe reduced and decreased (Tomisawa et al, 2013).

This paper was part of a study conceptualized to increase pre-service elementary teachers' knowledge and understanding on radiation and radiation risk as part of strengthening the foundation of their mastery of the subject matter in the sciences.

Objectives

This study attempted to find out the perception of pre-service elementary teachers on radiation and radiation risk.

Specifically it sought to find:

1. Terminologies, events, and instances associated with radiation

2. Students' perception on

a. what to know more on radiation and radiation risk

b. risk of radiation on human health

c. degree of radiation risk exposure to various activities, events, and instances

d. degree of danger to different radiation source exposure

e. fear of radiation

f. difficulty in understanding of radiation

g. effect of radiation to human body

h. interest on radiation

Methodology

This study adopted the descriptive design of research. It surveyed 200 university students that were taking up Bachelor in Elementary Education program under the College of Education in one of the state universities in the Philippines. These students were enrolled in a course in Physics in Health Sciences during the time of the survey.

Tables 1, 2, 3 and 4 summarized the respondents' distribution according to gender, age, elementary school attended and high school attended respectively.

Table 1
Distribution of respondents according to gender

Gender	Percentage
male	*16%*
female	*84%*

Table 2
Distribution of respondents according to age

Age	Percentage
17	*31%*
18	*50%*
19	*11%*
20	*8%*

Table 3
Distribution of respondents according to primary and intermediate school attended

Type of school	Percentage
rural elementary school	*63%*
central school	*35%*
private school	*2%*

Table 4
Distribution of respondents according to high school attended

Type of school	Percentage
national high school	*80%*
vocational school	*6%*
integrated school	*3%*
private school	*6%*

About 84% of the respondents were female of age 17 years old (31%) and 18 years old (50%). Majority of these respondents attended and finished studying in a rural elementary school (63%) for their primary and intermediate education and national high school (80%) for their secondary education.

Meanwhile, an adopted questionnaire developed by Tomisawa et al. (2012) was used in the study. Additional eight content-validated researcher-developed questions were added to establish the profile of the respondents. Selected individual interviews were also conducted to reinforce the results obtained from the survey. Quantitative data analysis included frequency counts, percentages and weighted mean. Data obtained from the interview were analyzed using the simple Collaizi method to find out themes and patterns from their responses to the questions and explanations.

Results and Discussion

A number of important findings were noted from the result of this study. About 24% of the respondents have at least one family member who underwent radiation-related tests and treatments. Moreover, 25% knew someone who has an occupation related to radiation. Therefore, it can be inferred that the respondents have limited sources of information about radiation and radiation risk. They may only have the opportunity to gain knowledge on these themes from school and mass media which may also be limited for certain reasons (Tomisawa, et al., 2012)

Table 5 presented the summary of the terminologies, events, and instances associated by the respondents to radiation.

Table 5
Terminologies, events, and instances associated with radiation

Terminologies, events, instances	Percentage
X-ray	*86%*
Chernobyl explosion	*11%*
nuclear power plant	*51%*
Hiroshima and Nagasaki bombing	*12%*
Marie Curie	*19%*
cancer	*88%*
Bataan nuclear power plant	*16%*
CT scan	*27%*
food irradiation	*9%*
Fukushima meltdown	*38%*
computers	*5%*
televisions (TV)	*8%*
cellular phones	*45%*
photocopying machines (xerox)	*43%*
Others	*7%*

Remarkably, cancer (88%) and x-ray (86%) were among the terminologies, events, and instances commonly associated by respondents to radiation. Considerable number of respondents also associate radiation to nuclear power plant (51%), cellular phones (45%), and photocopying machines (xerox) (43%). These terminologies, events, and instances associations maybe expected since schools, along teaching the effects of radiation, teachers usually cite cancer as an example while along sources of radiation, x-ray, nuclear power plant, cellular phones, and photocopying machines are usually cited.

Meanwhile, Table 6 showed the areas on radiation and radiation risk that the respondents wanted to know more.

Table 6
Areas on radiation and radiation risk that respondents want to know more

What to know more?	Percentage
radiation safety	*72%*
use of radiation in food processing	*10%*
use of radiation in industry	*24%*
radiation research	*16%*
actions to be taken in case of radiation-related accidents	*51%*
government regulations and laws on radiation	*14%*
facilities using radiation	*16%*
uses of radiation in agriculture	*8%*
uses of radiation in medicine	*22%*
radiation dose and effects	*71%*
sources of radiation	*65%*

Results reveled that majority of the respondents wanted to know more about radiation safety (72%), radiation dose and effects (71%), sources of radiation (65%), and actions to be taken in case of radiation-related accidents (51%). These areas chosen by majority of the respondents justified their fear and concern on radiation. It could be noticed that few respondents have an understanding that radiation, aside from the danger and threat it poses, it has also a number of advantages and practical uses in a number of fields such as industry, medicine, and agriculture.

On the other hand, Table 7 summarized the respondents' perceived effects of radiation to human health.

Table 7
Perceived risk of radiation to human health

Perceived health hazard	Percentage
infertility	*23%*
genetic disorder	*26%*
miscarriage	*7%*
brain disorder	*53%*
cataracts	*10%*
hair loss	*9%*
cancer	*73%*
skin disorders	*36%*
life shortening	*51%*
fetus deformation	*21%*

It revealed that majority of the respondents recognized that cancer (73%), brain disorder (53%), and life shortening (51%) are the immediate health hazards when exposed to radiation. This revealed a limited understanding on the effect of radiation to the human health. It may be expected that respondents would identify cancer as an effect of radiation exposure since it is the common example used in teaching, however, it should not be limited to cancer only since a number of health effects can also result to radiation exposure such as miscarriage, hair loss, and fetus deformation among others.

Similarly, Table 8 showed the perception of respondents on the degree of radiation risk exposure from the following specified activities/illnesses.

Table 8
Perceived degree of radiation risk exposure

Risks	Degree
riding motorcycle	*8*
drug addiction	*3*
surgery	*6*
obesity	*7*
cigarette smoking	*4*
STD; HIV	*2*
dengue fever	*5*
drinking alcohol	*6*
E. coli	*6*
x-ray	*9*

It showed that respondents perceived higher degree of radiation risk exposure from x-ray (9), riding motorcycle (8), obesity (7), surgery (6), drinking alcohol (6), and E. coli (6). This also revealed a limited understanding on radiation risk exposure. Considerable number of respondents associated radiation risk from activities, events, and other instances that have low or rather no presence of radiation risk.

Table 9 showed the perceived degree of danger from radiation exposure to various sources

Table 9
Perceived degree of danger from radiation exposure

Radiation sources	Degree
rocks and soil	*2*
cosmic rays	*6*
radon spring	*5*
chest x-ray	*5*
CT scan	*5*
radiation therapy	*6*
airport baggage inspection	*4*
air travel	*5*
nuclear testing	*8*
living near nuclear power plant	*8*

Results revealed that respondents perceived that nuclear testing (8), living near nuclear power plant (8), cosmic rays (6) and radiation therapy (6) as most dangerous. This also revealed a partial understanding on radiation risk. A number of respondents perceived a low danger level to some sources that were considerably dangerous such as x-ray. Although evidence may not be enough, but, it can be inferred that the respondents perceived a low-level danger to useful applications of radiation such as x-ray.

Meanwhile, Table 10 was a summary of respondents' distribution according fear of radiation.

Table 10
Distribution of respondents according to their fear of radiation

Degree of fear	Percentage
strongly	*23%*
moderately	*54%*
slightly	*21%*
not at all	*2%*

Results showed that respondents have moderate (54%) and strong (23%) fear of radiation. Explanations from this group were explored through individual interviews of 50 respondents. After employing simple Collaizi method it was found that 82% of this group mentioned about developing cancer while 64% mentioned about the effect of nuclear bomb.

Table 11 was a summary of the explanations deduced from the interviews. Respondents mentioned at least one of this terminologies or phrases.

Table 11
Summary of explanations deduced from the interviews about fear of radiation

Themes	Frequency
developing cancer	*41*
effect of nuclear bomb	*32*
death	*20*
acquiring illness/disease	*17*
nuclear disaster (Fukushima, Chernobyl)	*23*

The following were some excerpts from the interview:

"I fear radiation because it can cause cancer."
"It radiation napacancer ito hiya tas mapatay an tawo." (Radiation can result to cancer, then, eventually the person will die.)
"An ak maaram han radiation makaharadlok talaga ito hiya. Mapatay ka ada hito." (What I know with radiation is that it is fearful. You can die with it.)
"Pwede man gud makahimo hin nuclear bomb hito nga radiation." (Nuclear bomb can be made from radiation.)
"Pareho han nanabo ha Japan, an ira nuclear power plant nag buto. Delikado talaga." (Like what happened in Japan, their nuclear power plant exploded. Really dangerous.)

The moderate level of fear may be considered at a satisfactory level, however, explanations in the interviews revealed that most of their reasons for fear of radiation were not scientifically grounded. It may be inferred that the fear level of the respondents was a result to limited or low knowledge on radiation and radiation risk.

Meanwhile, Table 12 summarized the respondents' perceived difficulty in understanding radiation and radiation risk.

Table 12
Distribution of respondents according to their difficulty in understanding radiation and radiation risk

Difficulty in understanding	Percentage
strongly	*3%*
moderately	*41%*
slightly	*49%*
not at all	*7%*

Results showed that respondents have slight (49%) and moderate (41%) difficulty in understanding radiation and radiation risk. Interviews were also conducted to 30 respondents that belong to these groups. Among the themes that were deduced from the explanations were summarized in Table 13.

Table 13
Themes from the explanations on difficulty of understanding radiation

Themes	Frequency
explanations were not clear	*15*
was not tackled in school	*13*
no enough information available	*26*

The following were some excerpts from interviews made from these groups.

"Dire gud talaga ako nakakahinumdom about radiation na gindiscuss namun ha skul." (I cannot recall that we discuss about radiation in school.)
"Baga dire man gud klaro an explanations about radiation kun hain nakukuhan ngan kun anu gud an iya specific naeffect. It nababatian ha iya nga makaharadlok la hiya tas napa cancer." (Explanations about radiation is not really clear as to its source and specific effect. We only hear that it is fearful and it can cause to cancer.)
"It is difficult to get information about radiation. Sometimes we can hear from the TV."

This result may be justified by lack of available information about radiation and radiation risk. Although the different themes of radiation and radiation risk are first introduced in the basic science education program, it is not necessary that the respondents developed a complete understanding due to some reasons that are yet to be found.

Meanwhile, Table 14 was a summary of respondents' distribution according to their perception on the effect of radiation to human body.

Table 14
Distribution of respondents according to perceived effect of radiation to human body

Effect of radiation to human body	Percentage
strongly	*59%*
moderately	*39%*
slightly	*2%*
not at all	*0%*

59% of the respondents perceived a strong effect of radiation to human body while 39% perceived a moderate effect. In relation to this, explanations were also sought from 30 respondents who belong to these groups. All of these

respondents recognized cancer as the effect of radiation to human body. This also was an evidence of limited understanding along the effects of radiation exposure to human body, since there is a wide range of radiation effect to human body depending on the amount and length of exposure.

Table 15 was the summary of respondents' distribution according to their interest on radiation.

Table 15
Distribution of respondents according to their interest on radiation

Interest on radiation	Percentage
strongly	*58%*
moderately	*36%*
slightly	*6%*
not at all	*0%*

Results revealed that the respondents were interested on radiation. About 58% manifested a strong interest in knowing radiation and radiation risk. Interviews were also conducted to about 30 respondents who belong to this group to explore their reasons. Table 16 enlisted the themes of their explanations from the interview.

Table 16
Themes from the explanations along interest on radiation

Themes	Frequency
know the sources of radiation	*18*
know the effects of radiation	*20*
know what is radiation	*23*
know the uses of radiation	*14*

The following are some excerpt from the interview.

"I wanted to know kun diin natikang an radiation ngan kun anu an iya effect ha tawo ngan iba pa na effect." (I wanted to know the sources of radiation and its effect to humans and other effects.)
"Gusto ko masabutan kun anu gud ito nga radiation kay malain man an ak nababatian hito."(I wanted to know about radiation because it seems that I heard a lot of negative about it.)
"I am interested to know the effects of radiation especially to humans and also the uses of radiation. An ak maaram baga naka cure an radiation hin cancer but also naka cause gihap hiya hin cancer. (What I know is it can cure cancer but can also cause cancer at the same time.)

The respondents' satisfactory interest on radiation may have a positive implication along the teaching and learning of radiation and radiation risk.

Implications

The survey resulted a satisfactory perception of pre-service elementary teachers on radiation and radiation risk. However, individual interviews revealed an existing gap in the knowledge and understanding on the different aspects of these themes. Their perceptions were found to be based on daily experience and not deeply grounded on scientific evidences and facts. If not addressed, this may result to partial teaching of radiation and radiation risk to their future learners due to poor mastery of the subject matter. In addition, their strong interest about radiation may have a positive effect on the motivation to learn and know more about radiation and radiation risk.

Recommendations

It may be necessary to increase the respondents' knowledge and understanding on radiation and radiation risk to improve their current perception. In the case of the respondents, this will ensure an in-depth mastery of the subject matter, which may result to a better quality of teaching and learning radiation and radiation risk in the basic education upon their future field deployment.

Moreover, it may be necessary to reassess the place of radiation and radiation risk in the science curriculum from all levels. This will allow in finding out how the teaching of this themes unfold in the academic ladder through spiral progression.

Lastly, effective teaching strategies maybe developed to improve students' knowledge and understanding on radiation and radiation risk, therefore, improving the quality of the their risk perception.

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