

Student Training Program for Radiation Safety in Hanyang University: Research internship, Problem-based Learning, and Colloquium

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1. Introduction

Although radiation and its applications have great potential in modern technology, the need for radiation safety and social considerations remain major barriers to the active use of this technology. Especially, due to recent events such as the Fukushima nuclear accident and the radon bed mattress incident, the demand for radiation safety and the need for radiation safety experts is highly increasing. Therefore, it is necessary to provide nuclear/radiation students with radiation safety education and training to meet the public demand for radiation safety and its experts.

As part of this effort, we developed and implemented an education and training program for nuclear engineering students supported by K-CLOUD (KHNP-Creative & Leading Open-innovation for Ultimate R&D) of KHNP (Korea Hydro & Nuclear Power). This program included research internships, industrial-coupled problem-based learning (IC-PBL) classes, and radiation safety colloquium classes. We would like to share the results of this program.

2. Methods and Results

2.1 NUROP (Nuclear Undergraduate Research Opportunity Program)

The purpose of the NUROP internship is to enhance practical research skills, foster creativity, and promote teamwork by providing undergraduate students majoring in nuclear engineering with the opportunity to work as researchers in each laboratory within the Hanyang University Department of Nuclear Engineering. Over four semesters, we received a total of 72 applications and selected 42 students to participate in the NUROP program. Table I below provides the number of total and selected applicants, as well as the duration of the NUROP internship program for each semester. A temporary decrease in competition rates in 2022 summer of the NUROP program occurred due to an internship program at another university during the same period.

Table I: The number of total/selected applicants and the duration of the NUROP internship program for each semester

Semester	2021 summer	2021 winter	2022 summer	2022 winter
Total applicants	19	26	12	15
Selected applicants	10	11	12	9

Duration	4 weeks	4 weeks	4 weeks	6 weeks

The NUROP internship was held during the summer and winter vacation periods, taking into account the schedules of the participating undergraduate students. Each intern was assigned a research topic from their affiliated laboratory and was guided by senior graduate students from the same lab.

Following the designated period of the program, NUROP students created research posters showing their research outcomes. They publicly presented their research posters in a two-hour exhibition held at Hanyang University Nuclear Engineering conference room, during which they introduced their research contents and received feedback and questions from various participants, including professors, graduate students, and the general public. The research posters were evaluated by the committees consisting of 2-3 experts, based on evaluation metrics such as the creativity and appropriateness of the research topic, adequacy of the research methods, objectivity of the results, potential of the results, and the contribution of the intern students. Based on the evaluation, four outstanding students were selected as awardees, and all participants who completed the program without dropping out received a certificate of completion.

Of the 22 NUROP participants who have now graduated, 16 students (68.2%) entered graduate school. Among the 15 individuals who proceeded to graduate school, 14 of them chose to study in the department of nuclear engineering and 1 chose the department of mechanical engineering. We conducted a survey targeting a total of 38 program participants, asking them about their overall satisfaction with the program, their intention to recommend the program to others, and their satisfaction concerning career exploration. The results of this survey are shown in table II.

Table II: NUROP survey for program satisfaction (n=38)

	Program satisfaction	Intention to recommend the program	Satisfaction in terms of career exploration
Strongly agree	29 (76.3%)	30 (78.9%)	33 (86.8%)
Agree	8 (21.1%)	7 (18.5%)	5 (13.2%)
Neutral	1 (2.6%)	1 (2.6%)	0
Disagree	0	0	0

Strongly disagree	0	0	0
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From this perspective, the NUROP internship successfully provided an opportunity for undergraduate students interested in graduate school to experience radiation safety research and understand how real laboratories work.

2.2 IC-PBL (Industry-Coupled Problem-Based Learning)

An IC-PBL class is an educational model at Hanyang University in which learners solve practical problems of the real world through collaboration between industry, local communities, and research institutes. We designed the IC-PBL class for NUROP interns to help them enhance their problem-solving ability, practical research capacity, and interdisciplinary research capacity. The IC-PBL class for NUROP interns incorporates 4th Industrial Revolution technologies such as 3D printing into radiation measurement, protection, shielding, and medical fields.

In the IC-PBL class, students were given problems calculating the expected radiation exposure through shielding evaluation of radiation-related facilities using the MCNP code. For example, students learned 3D modeling software to design the shielding of a radiation treatment room with a linear accelerator. Then, they modeled and printed their own designed room. Fig. 1 shows the 3D printed output by NUROP interns.



Fig. 1. The 3D printed output of medical shielding design created by students in the IC-PBL class

The results of the IC-PBL class were evaluated by radiation safety experts. At the end of the program, interns gave a presentation of IC-PBL results individually or as a team.

Similarly to the NUROP, a survey targeted the total of program participants in 2022. The survey was about the interest of the class, acquisition of new knowledge, and satisfaction with the overall program. The survey results show that participants of IC-PBL acquired enhanced problem-solving skills and were able to learn the practical issues of the radiation safety field. Table III below is the results of the IC-PBL survey.

Table III: IC-PBL survey for program satisfaction (n=21)

	Interest in the class	Acquisition of new knowledge	Program satisfaction
Strongly agree	13 (61.9%)	14 (66.7%)	13 (61.9%)
Agree	7 (33.3%)	5 (23.8%)	6 (28.6%)
Neutral	1 (4.8%)	2 (9.5%)	2 (9.5%)
Disagree	0	0	0
Strongly disagree	0	0	0

Strongly agree	13 (61.9%)	14 (66.7%)	13 (61.9%)
Agree	7 (33.3%)	5 (23.8%)	6 (28.6%)
Neutral	1 (4.8%)	2 (9.5%)	2 (9.5%)
Disagree	0	0	0
Strongly disagree	0	0	0

2.3 Radiation Safety Technology Colloquium

The radiation safety technology colloquium is a newly developed graduate class as a shared course for undergraduate and graduate students at Hanyang University Department of Nuclear Engineering. The colloquium invites radiation safety experts from regulatory bodies, research institutions, the industry, and medical fields to discuss the latest trends, issues, and overall radiation safety technology, fostering networking opportunities with experts. The colloquium is conducted both online and offline in seminar-style sessions, allowing pre-registered students majoring in nuclear or radiation from other universities to participate. The lecture materials were compiled into books and distributed to three other universities.

A survey was conducted on 12 colloquium participants from other universities who participated in the 2022 spring colloquium to gauge their intention to recommend it, satisfaction with the practical knowledge gained, and satisfaction with the online format that we used. Table IV displays the survey results.

Table IV: Survey for radiation safety colloquium, targeting students from other universities (n=12)

	Intention to recommend the program	Satisfaction with practical knowledge	Satisfaction with an online format
Strongly agree	9 (75.0%)	8 (66.7%)	8 (66.7%)
Agree	3 (25.0%)	4 (33.3%)	4 (33.3%)
Neutral	0	0	0
Disagree	0	0	0
Strongly disagree	0	0	0

The survey revealed that all students were satisfied with the program and would recommend it to others. Participants were able to cultivate their practical knowledge through this colloquium, and the online format of the class was highly satisfactory. Therefore, the 2023 spring colloquium class will be also conducted using both online and offline methods.

3. Conclusions

To meet the increasing demand for radiation safety, we developed and implemented an education and training program at Hanyang University for nuclear engineering students, supported by K-CLOUD of

KHNP. The NUROP, IC-PBL class, and the radiation safety technology colloquium as parts of this program successfully provided opportunities for active learning, career exploration, and the development of problem-solving and practical research skills for undergraduate students in nuclear engineering. Based on the positive results of this program, we concluded that such education and training programs can have a significant impact on student improvement and career choice in the radiation safety field, and thus play a vital role in cultivating radiation safety technology professionals to meet the public demand for radiation safety.

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