

Seeding for Future Radiation Learning: the Two Magical Compost-containers in Elementary Mathematics

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Introduction and Objective

A number of teaching materials which are related to the radiation education have been developed, especially after the nuclear power plant accident in March 2011 in Japan (Fukushima Prefecture Board of Education, 2014; Otsuji, et al. 2014). However, most teaching models are classified into the deficit model or one-way knowledge transferring model, which does not consider the learners' cognitive developmental stages, comprehensive ability, nor present school curriculum. Additionally, it is argued that radiation education should be taught in the unit of integrated subjects rather than the unit of a certain subject. In this study, we developed and carried out a 45 min. mathematics lesson at grade four, which was situated at the end of the unit of the line-graph. While introducing two decreasing curves (half-life and inverse-square law) without using academic levels and mentioning about the radiation, we aimed at seeding the concepts for their future learning.

In the traditional radiation education, the half-life graph is popular but the inverse-square law has been paid less attention. However, the strength of radiation is inversely related to the square of the distance from the radioactive materials. It is quite important concept for citizens to know in terms of radiation defending.

Methodology

The lesson has been developed in the negotiation with the elementary mathematics teacher. She insisted that students needed to have a story to work on, and the initial value should be equal on both curves. Then, we introduced two magical compost-containers: Red container can reduce the volume of the garbage 50 % in one month and the blue one can make it one fourth in two months, one ninth after three months, one sixteenth after four months, etc. from the beginning. We had 3600[g] garbage at first for each container. We asked students which container could perform more efficiently in reducing garbage. Using calculator, students filled the blank in on the worksheet, drew the both graphs and discussed the solution.

Major findings

Being conscious on the students cognitive ability, the teacher made them notice that one scale represents 100 [g] on the graph sheet. With the help by the teacher and three supporters, students could accomplish the both tables and graphs. The graph of the blue container more sharply declined than that of the red one at first, however, two graphs crossed after sixth month and the amount of the red container was more reduced at the end. "They curve like the roller coaster!" As we expected, the students at grade four concentrated on calculating the values and drawing the curves. "We found the volume is decreasing gradually. Does it go down below zero as time goes in x axis?" Students at grade four have not learned the concept of asymptote in mathematics yet. However, adopting a devil's advocate, the teacher successfully made students acquire the concept by stimulating their thinking. According to the students' argument, the red container was more effective than the blue one in reducing garbage. However, a few students who focused on the dramatic decreasing of the first stage in the blue container persisted in saying "I would take the blue."

The introduction of the appropriate story, an adequate scale of graph on the worksheet, and a calculator as a powerful tool, such all conditions enabled all students to participate in and be successful in their learning.

Conclusion and Implications

When compared to the half-life curve, the inverse-square law curve has not been taught often in the radiation education, which releases that the radiation education has been mainly carried out from promotion side, not from the radiation defending and public safety. In terms of the radiation defending, the learners need to replace the axis of time the inverse-square law to that of the distance. Both curves illustrate that "big effect with little change." The trial lesson was successful in planting the seeds as a prior experience for students to notice in their future learning of radiation. No children realized that the lesson could be categorized in the radiation education. Students were also cultivated in their scientific thinking through the tutoring. However, it is better not to be used the concept in their future life.

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