The 4th Student's Research Project in the World Radiography Day 2022, Rangsit University Nov 8,2022

Black Box competition: Radiological technology education using Black Box phantom

Keisuke Kondo, Kazuo Shimura Faculty of Health Sciences, Komazawa University, JAPAN

1.Introduction

Education of the ability to "think and act spontaneously" is becoming increasingly important at universities. For this reason, university education is increasingly shifting from one-way lectures to "active learning," which is an independent, interactive, and deep learning method for students. One successful example of educational content that challenges students to solve problems using their expertise and creative ideas is a "Robot Competition. However, the use of "robot competition" as it is for the education of radiology technologists is not expected to have educational effects. The purpose of this study is to develop a problem-solving educational program like the "Robot Competition " that requires specialized knowledge and skills in radiological technology.

2. Cubic phantoms(XCUBE) and Black Box(BBOX)

We developed three types of cubic phantoms (XCUBEs) with different X-ray absorptivity. Each side of the cube phantom XCUBE is 20 mm in length and colored yellow, blue, and orange in descending order of X-ray absorptivity. We also developed a black box (BBOX) that can hold 27 cubic phantom XCUBEs, three each in length, width, and height. Figure 1 shows a row of 10 XCUBEs of each of the three types, and a photograph of the BBOX is shown at the top. The black box on the left side of the BBOX is a lid, and when placed over the black box on the right side, it becomes a cube. Figure 2 shows a photograph of the XCUBE inside a BBOX made of transparent material.

When 27 XCUBEs are placed in the BBOX and radiographs are taken from the top, front, and side, X-ray images of three stacked XCUBEs are obtained. The three XCUBE combinations produce images with 10 different densities. To increase the difficulty, the material of the XCUBEs is adjusted so that the density is the same for different combinations. Figure 3 shows 10 combinations of three XCUBEs selected from three different XCUBEs and their radiographic images. The areas circled in red in Figure 3 have almost the same density.

Figure 1 XCUBEs and BBOX

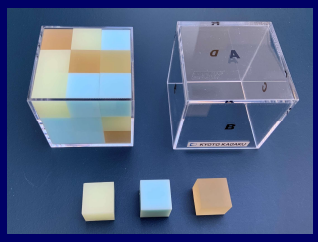

Figure 2 Transparent BBOX with XCUBEs

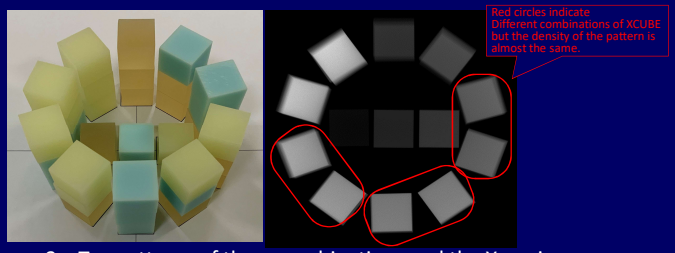

Figure 3. Ten patterns of three combinations and the X-ray image

3. BlackBox Competition Komazawa Univ. vs Kyorin Univ. On Nov. 23, 2021

Nine XCUBEs of each of the three types (27 total) were placed in the BBOX and sealed. Participants took radiographs of the BBOX from multiple directions and analyzed the images to estimate the color of the 27 XCUBEs. The first black box competition between two universities took place in 2021 during the covid-19 pandemic. The two universities communicated using a web meeting tool. Analysis was conducted using only paper and pencil. The use of programs and spreadsheets was prohibited.

Preliminary round: All teams were given the same five X-ray images of the BBOX containing the XCUBE, and competed on the accuracy and speed.
Final round: The best team from each university competes against each other; teams think about the placement of the XCUBEs in the BBOX, seal them, exchange BBOX (data exchange due to the Internet competition), and each team takes X-ray images and analyzes them. Additional shots can be taken within a time limit. Competition is based on accuracy, speed, and the number of shots taken.
Individual competition: During the finals, students other than the best team compete in an individual competition. As in the preliminary round, X-ray images prepared in advance will be used. However, only three images will be distributed at first, and additional images will be distributed upon request. Competition is based on accuracy, speed, and the number of images used.

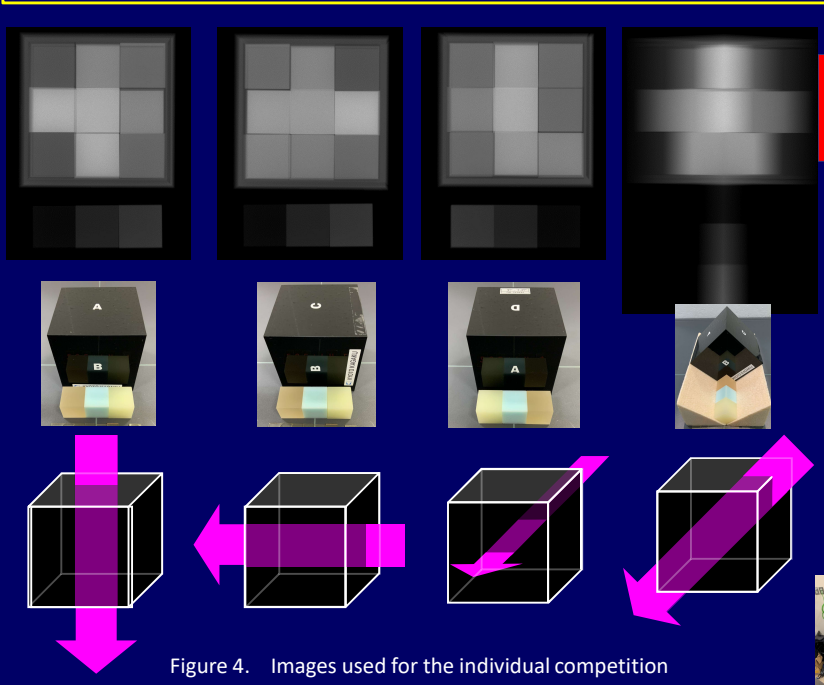

Figure 4. Images used for the individual competition

Let's Try

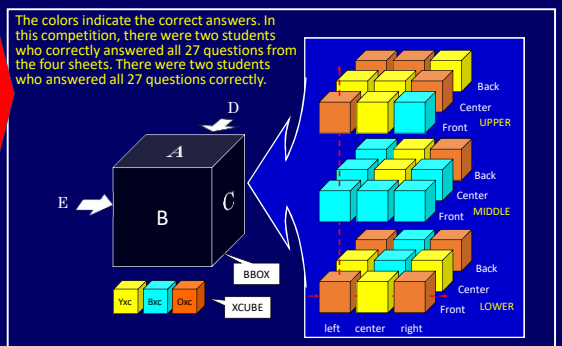

Figure 5. Correct placement in the individual competition

Scores (maximum 40 points)
Correctness: Number of correct colors in 27 locations x 1 point
Number of images: 3 => 13 points, 4 => 11 points, 5 = 8 points, 6 => 4 points, 7 => 0 points
Speed: In case of a tie, the first to analyze the image wins.

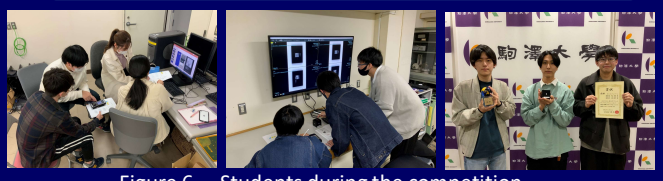

Figure 6. Students during the competition

4. Results and Discussion

Seven teams from two universities participated. In the preliminary round, one team from each university won by correctly estimating the color of all XCUBEs. The winner of the finals was 38 points with 27 correct guesses and 4 pictures taken. In the individual competition, there were two students who received 38 points for 27 correct answers and 4 pictures, and the student who was the fastest in analyzing the images won the competition.

In the questionnaire after the competition, students were asked whether "learning to analyze images," "learning to think," "teamwork," and "communication skills" were useful. About 80% of the students answered "very useful" or "useful" for all of them, indicating that the competition is expected to be a problem-solving type educational program. Four university faculty members were involved in the program, and all of them evaluated that the program was useful as a problem-solving educational content and that the students' attitudes were very positive.