

Development of inquiry-based courses about biomedical technology in general education classroom

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Abstract

Carbohydrates play an important role in directly influence human health and diseases. On the surface of viruses or cancer cells, there are special structures of carbohydrates, called glycans, which can be used as special marks in biomedicine. In recent years, glycan array and glycan-based vaccines have developed from biomedical technology to screen viruses or treat cancer to diagnose and predict the carbohydrate-mediated diseases. However, these knowledge and technology are little understood by the public including college students because of their owning abstract concepts and lacking an appropriate course. Besides, there are relatively little inquiry-based courses at colleges although they have been widely implemented in K-12 education. Consequently, the research aimed to design the inquiry-based courses in general education to improve college students' comprehending of glycan array and glycan-based vaccines, as well as the related concepts and mechanisms about them, for example, antigens and antibodies. The building blocks with an Arduino device were used to simulate the mechanism of glycan array and glycan-based vaccines and further provided college students with an inquiring tool about producing an immune response. The results are believed that inquiry-based courses can foster college students' science learning and understanding of biomedical technology.

Keywords: informal science education, biomedical technology, glycoscience

Informal science education

- The public's understanding of science requires not only formal education in schools and their experience in daily life but also need informal science education addressed by media, museums, and science exhibitions (Bell, Lewenstein, Shouse, & Feder, 2009).
- Through these media, activities, and interaction with tour guiding, the public has the opportunity to be familiar with scientific knowledge, comprehend the latest scientific research results, and influence how they view scientific and technological issues (Todd & Zvoch, 2019).

Biomedical technology

- In recent years, biomedical technology is one of the frontier technologies that Taiwan's key development approach, especially the research of glycoscience. In addition, glycan array and glycan-based vaccines have developed from biomedical technology to screen viruses or treat cancer to diagnose and predict the carbohydrate-mediated diseases.

Inquiry-based learning

- An Inquiry is a better way that fosters learners to develop their scientific reasoning abilities, critical thinking, and scientific concepts (National Research Council, 1996; Suárez, Specht, Prinsen, Kalz, & Ternier, 2018)
- Inquiry-based learning involves a process of actively exploring the new phenomena, relationships between these phenomena, and the causes of them by asking questions, formulating testable hypotheses, designing experiments executing experiments, analyzing the data of experiments, acquiring the results of experiments, and communicating these results with others (de Jong, 2006; Jaakkola & Nurmi, 2008)
- Inquiry-based learning also requires students to conduct scientific reasoning and apply critical thinking when combining scientific knowledge and processes to generate a perception of science (Bianchini & Colburn, 2000; Duran & Dökme, 2016).

Research purposes

- Design the inquiry-based courses in general education to improve college students' comprehending of glycan array and glycan-based vaccines, as well as the related concepts and mechanisms about them.
- Understand the courses the effect of college students' science learning and understanding of biomedical technology.

The course of glycan array

- We developed a device with an Arduino to simulate the glycan array mechanism, which the LED light bulbs brightening shows the types of the specimen can be detected. In the beginning, students got several unknown solutions, and teachers made them predict whether exists the designated antigens. After predicting those antigens, students operated the experiments that the solutions were detected by the device and observed the phenomena of experiments. When the sugar molecules on the surface of the antigens react with specific sugar molecules on the device, the different kinds of LED light bulbs will brighten according to the different antigens. Finally, students examined whether their prediction was consistent with the observation of the experiments and gave explanations to them.



Fig 1. The device with an Arduino to simulate the glycan array mechanism.



Fig 2. The LED light bulbs on the device brighten when the designated antigen binding to the antibody.

The course of glycan-based vaccines

- The building blocks with an Arduino device to imitates the mechanism of glycan-based vaccines. When patients with cancer are injected with vaccines using particular carbohydrate molecules as vaccine antigens, they can activate the patients' immune system to produce antibodies against cancer cells and eliminate cancer cells.

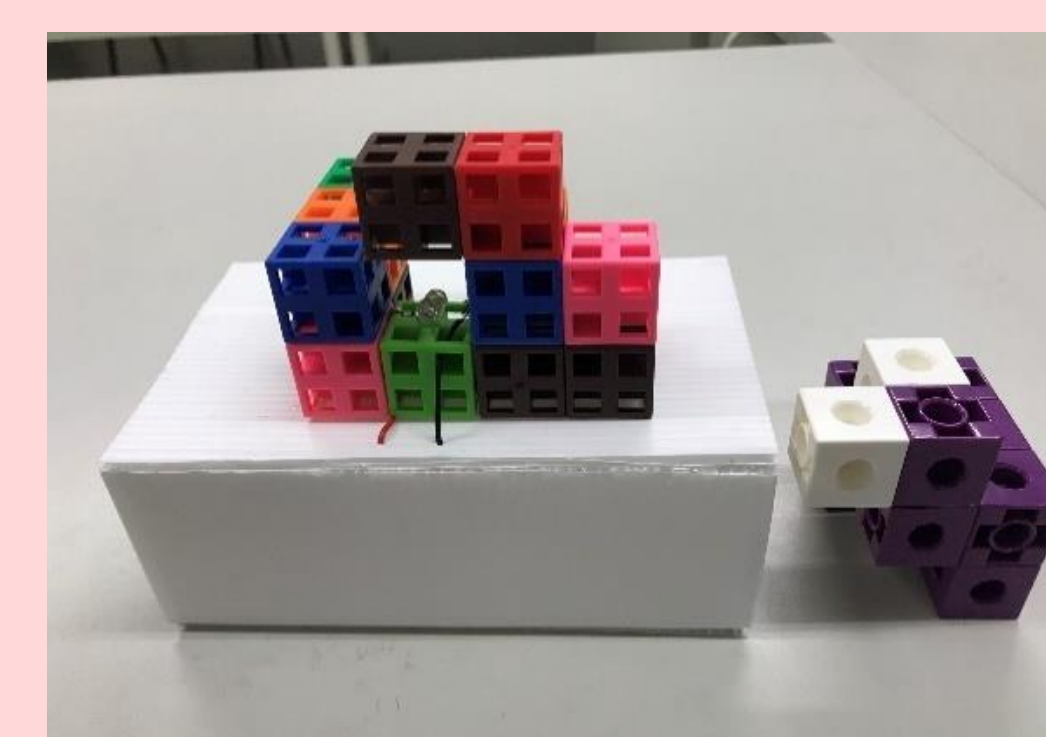


Fig 3. The different kinds of building blocks are analogous to antigen and antibody, respectively.

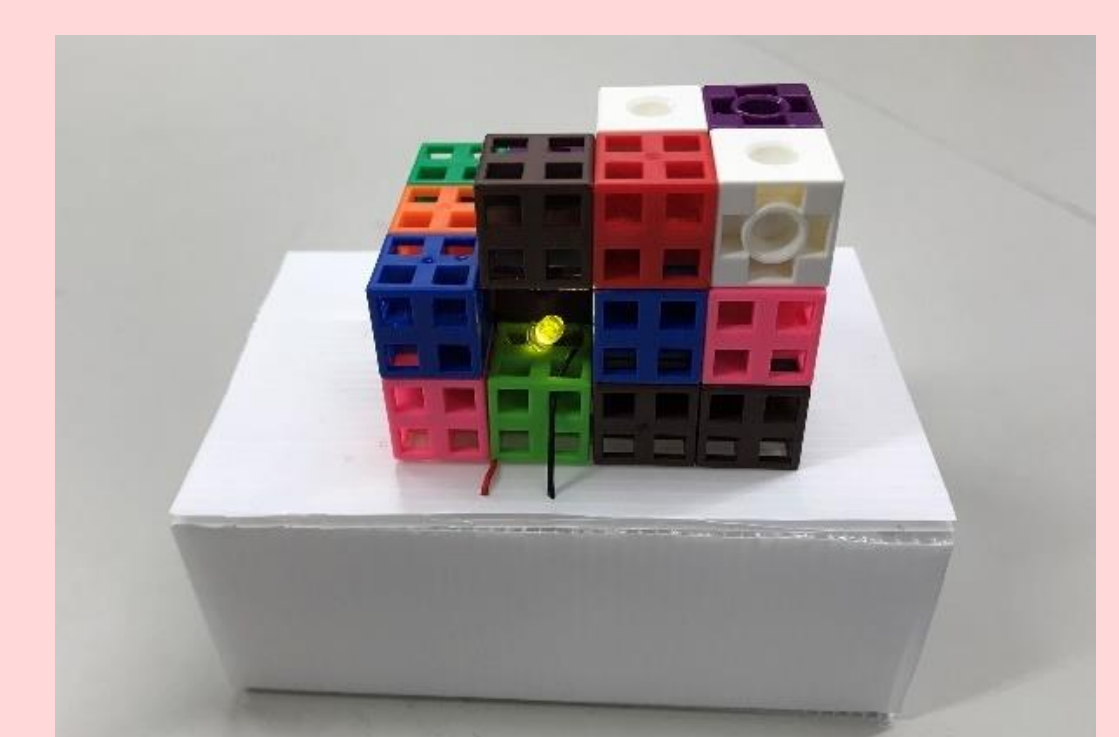


Fig 4. The LED light bulb glows when the building block symbolizing the antigen successfully combined with the building block corresponding to the antibody.

Conclusions

- It is believed that our results not only make us understand inquiry-based courses can foster college students' science learning and understanding of biomedical technology.