DEVELOPMENT OF SECONDARY SCIENCE EDUCATION PROGRAM THROUGH ASTRONOMICAL OBSERVATION PRACTICE

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Background of Development

- Students use various prior experiences in the process of constructing scientific knowledge, so that students with prior experience are better able to construct scientific knowledge and, thus, better scientific learning.
- In astronomy, however, it is not easy for students to have such experiences because they require systematic and repeated astronomical observations and equipment to help them have enough experience to build relevant scientific knowledge.
- In order to overcome these limitations, we have developed a science education program based on astronomical observational practices that will support students' experiences.

Theoretical Background

Modeling

- The model in science is a system for explaining and predicting the process of finding the cause of natural phenomena, and it encompasses the interaction of theory, concept, content, process, and various elements of phenomena (Gilbert, 1991).
- Models have the role of promoting scientific inquiry skills and producing and disseminating scientific knowledge (Gilbert, 2004), enabling them to explain or predict scientific phenomena (Van Driel et al., 1999)
- The modeling process helps to improve scientific inquiry ability and expressive ability because it requires active interaction of learners to construct the best model (Schwarz, & White, 2005).

Mathematical Modeling

- A **mathematical model** is a mathematical structure created by using mathematical concepts such as functions or equations while possessing a certain characteristic of phenomena (Edward & Hamson, 1989), and this mathematical modeling process is called **mathematical modeling**.
- The use of mathematical modeling in the scientific context is beneficial both in mathematics education and in science education.
  - Mathematics should be taught within a realistic and concrete context (Kim, 2012).
  - Scientific phenomena can be represented quantitatively using a tool called mathematics, which allows for more extensive analysis.
- As astronomical phenomena are suitable for mathematical representation, mathematical modeling can be used.

Aims of program

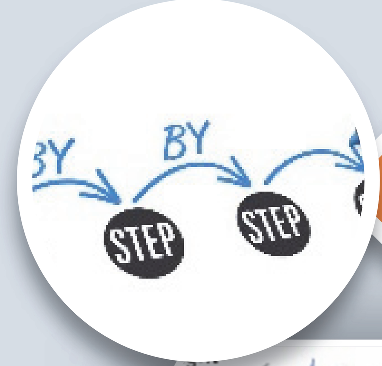
- ***Enhancing Interest in Science*** - School classes in Korea are largely made up of textbook-based lecture classes tailored to the national curriculum, which makes students less interested in science than other countries (OECD, 2016). Participation in scientific inquiry promotes students' interest in science (Jocz, Zhai, & Tan, 2014). Therefore, we intend to provide inquiry-based science lessons to enhance the interest of Korean students in science. This class does not provide a recipe-like materials in the cookbook. Students design their own research, collect the necessary data, and analyze it using a computer. Teachers are helpers, not knowledge carriers. They only provide some support for students' difficulties and do not provide answers.

- ***Learn the techniques for collecting and analyzing data*** - In order to carry out a designed study, the data must be collected directly using a telescope and analyzed. The necessary skills are not provided in the school curriculum. Students learn how to use the telescope and how to shoot the camera on Day 1, and they learn about Microsoft Excel, a simple data analysis program, on Day 4. It needs a lot of time for practical training, not just memorization, but also the ability to practice. By giving a simple scaffold, it helps students to acquire that skill.
- ***Promoting understanding of 'Nautre of Science'*** - By doing science as a scientist, students enhance his understanding of "Nature of Science." Students often understand scientists as a lonely person who lacks social skills and performs experiments on their own, but the real science is not. Science requires collaboration with various people, requires sociality, and interacts well with the group. Students also recognize that science is a very efficient discipline. they think that if they do research by planned design, they can get the desired result easily. However, no matter how well the experiment is designed, it requires a lot of trial and error and repetition in science.

Conclusion

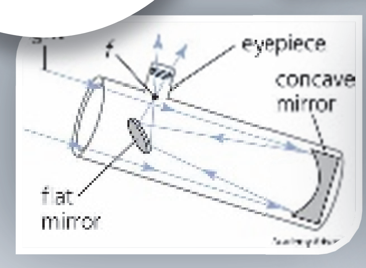
- It is expected that students will participate in the acquisition of observation skills and experimental design with a higher interest and goal consciousness, because the above four steps are organically organized so that true learning can be done beyond simple practice. Students are also expected to deepen their understanding of doing science by designing and analysing experiments together in small groups.
- The reason why practice-based teaching cannot be done in the field despite the fact that it is beneficial to the students is because there is no module for education programs. Therefore, it is necessary to fully develop and disseminate practice-oriented education programs based on theoretical research.

Overview of Instruction



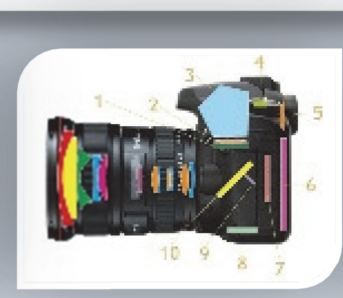
Day 1. Fundamental Stage

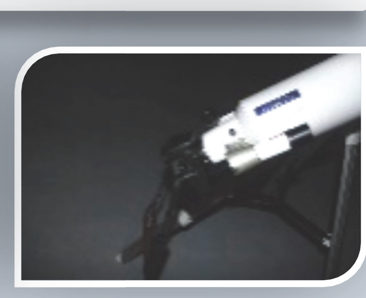
Teachers and students share the problem.



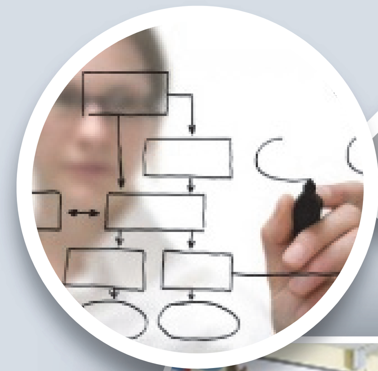
Structure of Telescope


Telescope setup


Structure of DSLR camera


Prime Focus Photographing

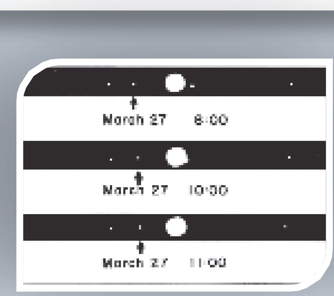
Teachers and students share the problem. They will obtain the sidereal period of satellites and mass of his mother celestial bodies. Students will also learn how to use telescopes and digital cameras for the first time astronomical observations.

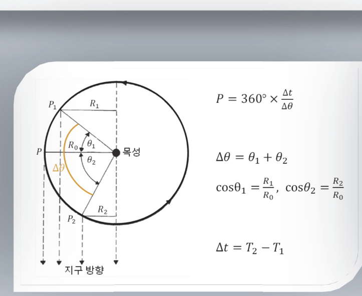


Day 2. Design Stage

Students design an experiment to solve the problem.


Group Research Design


Analysis of Sample Data


Mathematical Modelling

$$M \approx \frac{4\pi^2}{G}\frac{a^3}{P^2}$$

Discovering the Kepler's Third Law

Students design an experiment to solve the problem. Rather than simply presenting a solution to the problem like a cookbook recipe, teachers let students think about what they need to do and how to analyze them. Students discuss how the moon moves relative to the background stars, and group models are co-constructed. After that, the whole class share group models and criticizes each other's models. The teacher leads the discussion in the right direction to help you carry out the right experiment. Modeling of the Jupiter satellite is also similar to the relative motion of the moon mentioned above.

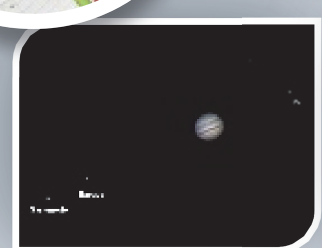
Day 3. Practice Stage

Students collect the necessary data that they planned at the design stage.

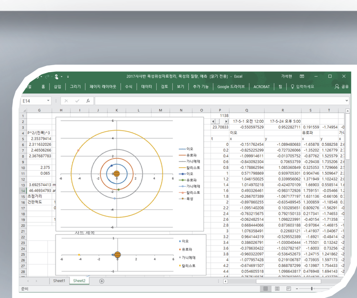
Students collect the necessary data that they planned at the design stage. Data must be insufficient to obtain sidereal periods because of time limitation, so teachers will provide some data.

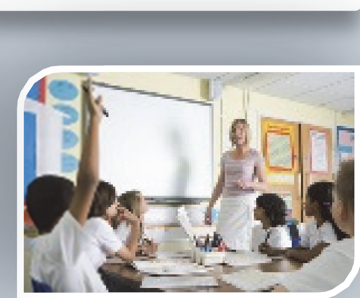
Day 4. Analysis Stage

The data obtained during the practice phase are analyzed and the research problem is solved.


Analysis of Data


Group Discussion


Analysis using Computer


Reflection

The data obtained during the practice phase are analyzed and the research problem is solved. Because the students do not know how to use the program to analyze the data, the teacher teaches them how to use Microsoft Excel. Before analyzing the data, learning about Microsoft Excel is performed separately. The data used as example in learning of tool is similar to but different from the actual data and analysis. Once the data is analyzed by the group, the whole study shares the results together. Students criticize each groups' results and share their opinions on how to make it a better practice.

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