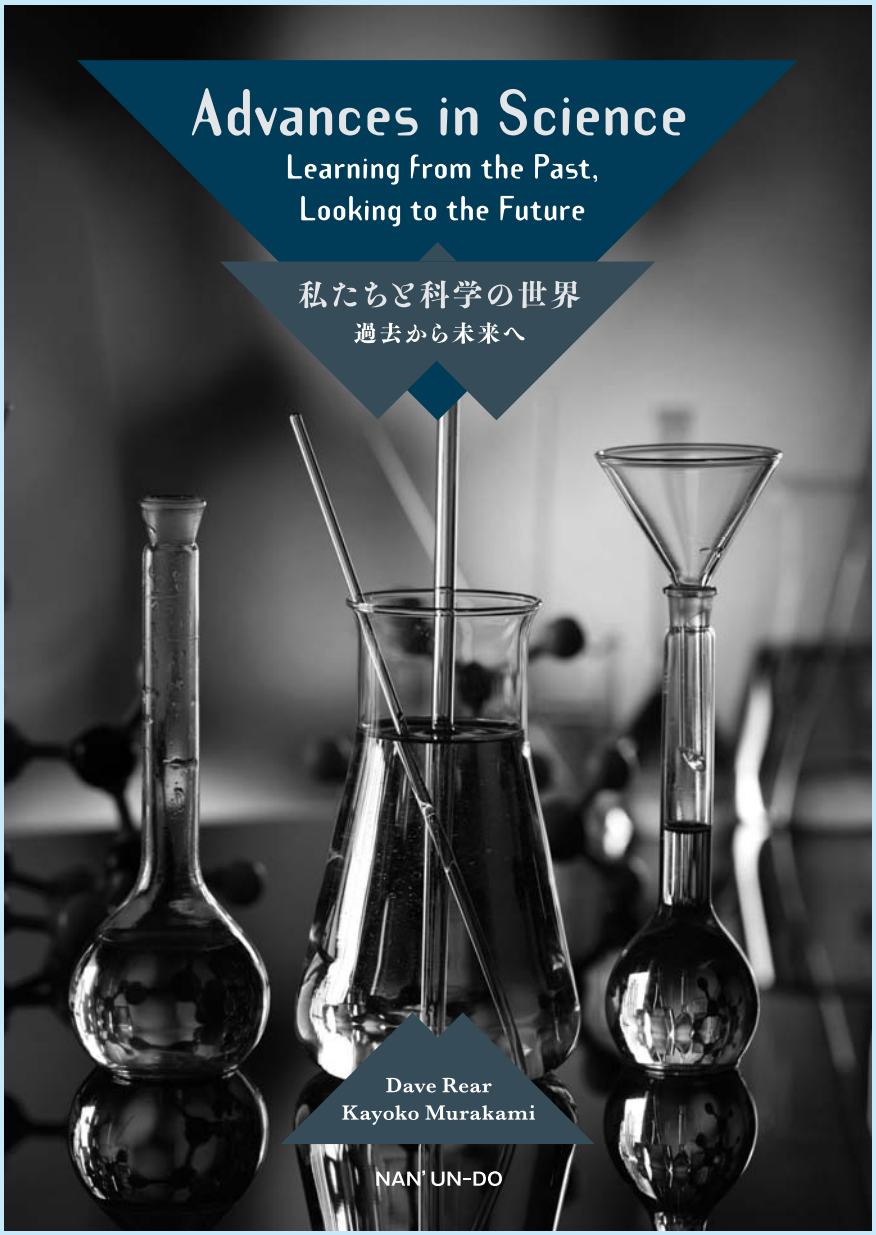
Advances in Science
Learning from the Past,
Looking to the Future
私たちと科学の世界
過去から未来へ
Dave Rear
Kayoko Murakami
NAN'UN-DO

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To Teachers and Students

Sometimes we need to look backwards in order to look forward. That is to say, in order to understand the world of science today and where it may be heading tomorrow, it helps to know where it has been in the past. How did we come to our present understanding of atoms, energy, gravity and light? What are the fundamental principles through which we investigate the world around us? Who are the great scientific figures who helped us to find our place in the universe? This book aims to answer these questions, guiding students from the past to the present and from the present to the future.

It is divided into five main sections, each with three units that illustrate the major theme. The first section deals with the fundamentals of science, showing how we learned to investigate the universe through the scientific method and read it in the language of mathematics. In the second section, we see how some of the great scientific thinkers of history built upon these fundamental principles to make stunning discoveries about the nature of light, electricity, radiation and the human body. In the third section, we look beyond our own world into the vastness of space. We learn about the mysteries of gravity and atoms and discuss the possibility that human beings will one day leave our solar system and travel to distant space. The final two sections of the book connect our present understanding of science with the future of technology. We look at nanotechnology, genetic engineering and artificial intelligence, and ask how such advances will change our world and, just as importantly, whether these changes will all be to our benefit.

To guide students through the topics introduced in the book, each unit has a number of different activities for them to complete. They consist of two vocabulary exercises, one pre-reading and the other post-reading, which give practice in using the key terms introduced in the article. There are also two comprehension activities, the first a reading exercise based on true / false questions and the second a listening exercise in which students predict the answer and check it with the audio. Following this is a grammar activity which helps students to increase the complexity and accuracy of their sentence building, and a technical exercise introducing language commonly used in the scientific world, from formulas, shapes and dimensions to graphs, directions and equipment. The unit ends with a pair of discussion questions which encourage students to use their own experiences and opinions to think beyond the topic. Thank you for taking an interest in this book. I hope you enjoy using it!

Dave Rear

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Unit 1: The Scientific Method

The scientific method is the basis for how experiments are carried out and new scientific discoveries are made. But what are the steps involved in the method? And who were the first scientists to start using it?

Key Vocabulary

Match the following words with their meaning.

1. theory	(a) to carry out, perform
2. conduct	(b) to stress the importance of something
3. observation	(c) a quality or characteristic
4. emphasize	(d) an idea that aims to explain something
5. property	(e) the act of watching something carefully

Reading

2

If you have ever carried out an experiment at school or university, you have probably followed some version of the scientific method. The scientific method consists of a series of steps that should be completed in order to test a particular theory or make a new scientific discovery. Briefly put, these steps are as follows: First, ask a question about something you have observed: how, why, what, etc. Second, conduct background research to gain more information about the topic to which the question relates. Third, based on this background research, construct a hypothesis, which is an educated guess about what the answer to your question might be. Fourth, design and perform an experiment in order to test your hypothesis. Fifth, carefully record the results of your experiment and analyze the data you have collected. Finally, conclude whether to accept or reject your hypothesis and communicate your findings in the form of a report or presentation.

Nowadays the scientific method is one of the fundamental principles through which we attempt to increase our understanding of the world around us. But it was not always the case. Although some ancient Greek philosophers advocated the use of systematic observation in order to draw up theories about the natural world, the scientific method as we know it today is generally traced back to the work of scholars such as Francis Bacon and Galileo Galilei. Francis Bacon was born in England in 1561 and educated at Cambridge University, where he became critical of the methods used to teach science. Emphasizing a methodical and skeptical approach to knowledge, Bacon insisted on the use of artificial experiments to verify conclusions about the natural world. Although the precise methods employed by Bacon differ from those used in science today, his so-called 'empirical' approach was the foundation upon which the modern scientific method was built.

Bacon's work was the inspiration for other scientists of his age, such as Isaac Newton and Galileo Galilei. Both of these great thinkers combined an empirical approach with a deep understanding of the importance of mathematics. Galileo conducted a large number of experiments during his illustrious career, with one famous, if unproven, story saying that he once dropped two balls of different weights from the Leaning Tower of Pisa in order to prove that an object will fall to the ground at the same speed, regardless of its mass. Newton, meanwhile, discovered, amongst many other things, the properties of light by refracting white light through a prism in order to split it into the colors of the rainbow.

Bacon, Newton and Galileo have been called the 'fathers of modern science.' The empirical methods they pioneered still form the basis for how new discoveries are made today.

(l. 7) hypothesis 仮説　(l. 12) principle 原理　(l. 14) advocate ～を主張する
(l. 16) scholar 学者　(l. 18) skeptical 懐疑的な　(l. 19) verify ～を検証する，証明する
(l. 26) illustrious 輝かしい　(l. 29) refract ～を屈折させる

Reading Comprehension

Decide if the following statements are true (T) or false (F).

1. (　) In the scientific method, the hypothesis is constructed after conducting background research.
2. (　) An experiment must always prove the hypothesis is correct.
3. (　) The scientific method used today is usually traced back to Greek philosophers.
4. (　) It was Francis Bacon who first advocated an empirical approach to scientific discovery.
5. (　) Newton showed that white light is made up of different colors.

Listening Comprehension

3

Predict the correct questions for the answers below. Then check your responses with the audio.

1. _____
There are six of them.

2. _____
That objects will fall to the ground at the same speed.

3. _____
Because they advocated the empirical methods that are used in modern science.

Words in Science

Choose the correct word for each sentence from the list below.

1. Antoine Lavoisier was a famous _____ in the fields of chemistry and biology.
2. Through the experiment, the researchers' _____ was proved to be correct.
3. A ray of light will _____ when it passes through glass.
4. Hopefully we will able to _____ our conclusion when we analyze the data.
5. The technology behind these devices is all based on the same _____ .

hypothesis　principle　scholar　verify　refract

Understanding Technical Language – Formulas I

Following the example given, complete the exercise below.

Ex: $a\,(\,b + c\,) = ab \times ac$ — *a* open brackets *b* plus *c* close brackets equals *ab* times *ac*

Ex: $A = \frac{dy}{dx}$ — capital *A* equals *dy* over *dx*

1. *x* plus *y* equals *a* over *b* _____
2. *x* open brackets 8 minus *a* close brackets equals *y* _____
3. capital *m* equals *a* plus *b* all over *c* _____
4. $\frac{a}{b} \times \frac{c}{d} = \frac{ac}{bd}$ _____
5. $A = R\,(\,1 + \frac{r}{n}\,)$ _____

Building Sentences – Active and Passive Verbs

Following the example given, re-write the sentences below.

Ex: [Active] The scientists *used* the scientific method in the experiment.
[Passive] The scientific method *was used* in the experiment (by the scientists).

1. [Active] The researchers *passed* an electric current through the liquid.
   [Passive] _____
2. [Active] The scientist *mixed* oxygen with hydrogen to produce water.
   [Passive] _____
3. [Passive] A model *was created* by the engineers as a first step.
   [Active] _____

Discussion

Talk about these questions with your classmates.

1. When did you become interested in science? Why does science interest you?
2. Have you ever carried out an experiment in school or university? Did you follow the scientific method described in the passage?

Unit 2: Observing the Solar System

It was not until the 17th century that we began to understand the Earth's position within the solar system. The discovery that the Earth revolves around the Sun, rather than the other way around, was a hugely important moment in science. Why is this?

Key Vocabulary

Match the following words with their meaning.

1. assume	(a) to move or revolve around something, like a planet around the Sun
2. orbit	(b) to investigate a place or topic you do not know much about
3. propose	(c) to believe something is true, even without proof
4. precise	(d) exact and accurate
5. explore	(e) to suggest an idea or plan