ΠΑΝΕΠΙΣΤΗΜΙΟ ΑΙΓΑΙΟΥ

English I

Course Unit 8: Reading and Grammar 5

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Με τη συγχρηματοδότηση της Ελλάδας και της Ευρωπαϊκής Ένωσης

Reading 5: Chaos Theory

THE 'BUTTERFLY EFFECT'

It is said that the movement of a butterfly's wings in a jungle in South America can cause a tornado in Asia. This idea is the basis of what is now called "chaos theory". But what exactly is chaos theory, what is its importance?

The mathematician Henri Poincaré first described chaos theory at the beginning of the 20th century, as how "differences in the initial conditions produce very great ones in the final phenomena." Its modern form was first described by the meteorologist Edward Lorenz in 1960. Lorenz was working on the problem of weather prediction. He set up a computer, not to predict the weather, but to develop a system to predict cycles and changes in weather conditions. He noticed that even though he sometimes put in the same data, the results would come out differently. After trying again and again, he realized that this wasn't a mistake: the same input could have many different results.

Then, in the late 1960s, another mathematician, Ernst Mandelbrot, did a similar experiment. He put 100 years of New York stock exchange cotton prices into a large, old-fashioned computer and noted that every change in price appeared to be random and unpredictable.

That's why this phenomenon is called "butterfly effect". The flapping movement of a butterfly's wings creates tiny changes in the atmosphere which, over the course of time, cause it to diverge from what would have happened without the flapping. This can eventually cause something as dramatic as a tornado. A small change in the initial condition of the system causes a chain of events which can lead to more serious and larger phenomena.

But chaos theory isn't only about butterflies and tornadoes. Aspects of chaos theory show up in all areas of our lives, from the smallest to the biggest: from the currents of the ocean to the flow of blood through our bodies, from how tree branches grow to the effects of turbulence on an aeroplane, from how the planets in the solar system move to how exactly milk mixes with your morning coffee. Chaos models can be used to plan traffic flow and thus avoid jams, to make long-range economic forecasts and predict the effects of population growth.

It now seems that together with relativity and quantum mechanics, chaos theory will be one of the greatest discoveries of 20th century.

A. Choose the correct answer.

1. Henri Poincaré
   a. discovered chaos theory.
   b. created the term chaos theory.
   c. made basic observations about chaos theory.
   d. made notes about mathematics.

2. Edward Lorenz
   a. tried to predict the weather using a computer.
   b. wanted to find a system to help weather forecasting.
   c. developed a computer programme to explain chaos theory.
   d. made a mistake.

3. Lorenz's programme
   a. showed that the same data can have different results.
   b. contained errors.
   c. always produced the same results.
   d. produced inaccurate results.

4. Ernst Mandelbrot
   a. wanted to make money on the stock exchange.
   b. noted the concept of unpredictability in his experiment.
   c. worked for 100 years on his experiment.
   d. made an experiment which was old-fashioned.

5. The "butterfly effect"
   a. is of interest to biologists.
   b. is of interest to meteorologists.
   c. is an example of applied chaos theory.
   d. shows how dangerous butterflies are.

6. Chaos theory
   a. can have many practical applications.
   b. must include lots of different subjects.
   c. is always about physical movement.
   d. controls all aspects of our lives.

B. Try to change the following words with an ending or a beginning, to create new ones. All the words you need appear in the text.

1. **important**: the noun? …….
2. **mathematics**: the person? …….
3. **meteorology**: the person? …….

4. **predict**: the noun? ……
5. **predictable**: the opposite? ……
6. **cause**: the verb? ……
7. **economist**: the adjective? ……
8. **grow**: the noun? ……

C. Try to write a summary of the text, based on the sentences below.

Although it was first described at the beginning of the 20th century, the modern form of chaos theory
……
……
Their experiments showed that
……
This phenomenon was called the 'butterfly effect' because
……
……
Chaos theory can be used
……
……

Answers to the exercises

Exercise A

1. c (par. 2: "The mathematician Henri Poincaré first **described** chaos theory at the beginning of the 20th century..")
2. b (par. 2: "He set up a computer, not to predict the weather, but to develop a system to predict cycles and changes in weather conditions")
3. a (par. 2: "He noticed that even though he sometimes put in the same data, the results would come out **differently**")
4. b (par. 3: "and noted that every change in price appeared to be random and **unpredictable**")
5. c (par. 4-5: "That's why this phenomenon is called "**butterfly effect**" ," and, "A small change in the initial condition of the system causes a chain of events which can lead to more serious and larger phenomena. But **chaos theory** isn't only about butterflies and tornadoes…")
6. a (par. 5: "Chaos models can be used to plan traffic flow and thus avoid jams, to make long-range economic forecasts and predict the effects of population growth")

Exercise B

1. importance
2. mathematician
3. meteorologist
4. prediction
5. unpredictable
6. cause
7. economic
8. growth

Exercise C (Suggested answer)

Although it was first described at the beginning of the 20th century, *the modern form of chaos theory was described by the meteorologist Edward Lorenz and the mathematician Ernst Mandelbrot in the 1960s.* Their experiments showed that *the same data can have many different results*. This phenomenon was called the 'butterfly effect' because *as the butterfly's wings might cause a tornado, a very small change in a system can cause very large phenomena*. Chaos theory can be used *in many areas (e.g. economics or demographics) and will be considered one of the great discoveries of our century.*