

2

Nurturing Young Scientists Through STEM



**Science and
Technology
Security**

Science and technology security refers to the security of science and technology itself and the technological support for safeguarding the security of related fields. Covering a variety of aspects such as technological personnel, facilities and equipment, scientific and technological activities and outcomes and the application of outcomes, science and technology security serves as a major supporting force and the technological foundation of national security.



Nurturing Young Scientists Through STEM

[1] Finding innovative ways to teach young children STEM can be very challenging. Indeed, science and technology can help a country develop and flourish. It is also an important part of protecting a country's science and technology security! Over the years, our country has definitely produced many scientists whose inventions and discoveries have made the world a better and safer place. Read on to find out more about them!

[2] Today, the way we live has become more and more technologically advanced. In order to protect our homeland and standard of living, we will need people with the right skills (like scientists) to keep up with this changing world. These individuals will be able to discover new scientific knowledge and invent more advanced technology, which allows us to deal with problems like new diseases and global warming. In order to nurture more scientists, we will need to focus on STEM (Science, Technology, Engineering, and Mathematics) education in children.

What Is a Scientist?

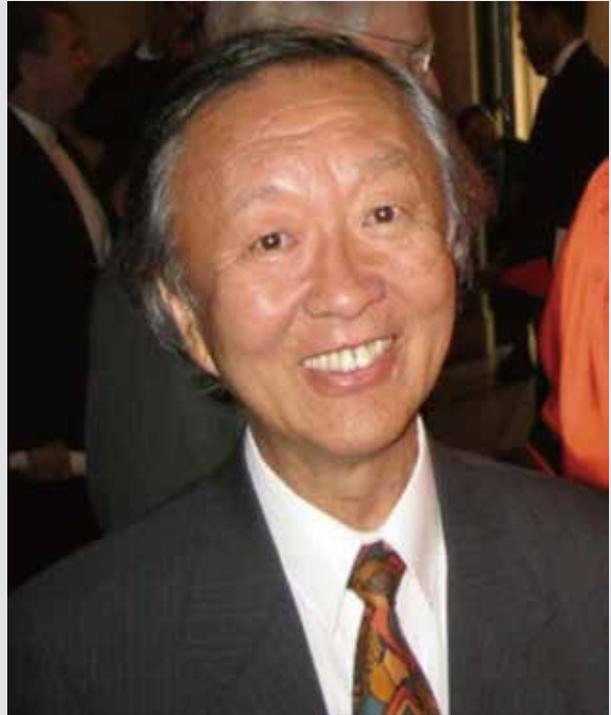
[3] A scientist is someone who has expert knowledge in a particular area of natural or physical science. Different types of scientists have their own special areas of research. For example, chemists study substances and their chemical reactions; biologists study life and living things; microbiologists study very small living things like bacteria; physicists study the laws controlling the natural world; geologists study the history and structure of the earth; zoologists study animals; archaeologists study ancient cultures; and astronomers study outer space. So what do these scientists actually do every day? Well, it depends on the kind of scientist they are. Not all scientists work in a lab and wear white coats and goggles. A physicist or biologist might spend more time designing and carrying out experiments. A zoologist might be out in the field investigating animals. An archaeologist might study objects found in ancient ruins. An astronomer might spend hours with a telescope observing stars and galaxies. Most scientists also find themselves writing reports and publishing scientific papers.

‘China is changing into an advanced economy with talented and knowledgeable individuals. In the past, China’s economy was based on mass-production and exports.’

The Father of Fibre Optic Communications

[4] Scientific discoveries made by scientists often lead to amazing inventions. Have you heard of Charles Kao? He was a famous Hong Kong physicist and engineer. He discovered how to use fibre optic cables for telecommunications (which means exchanging information electronically over distances, such as by telephone). In the 1960s, Kao made incredible discoveries about the properties of glass. He discovered how to make glass into thin fibres. These fibres can then be used to send information over long distances.¹ Fibre optic cables (or fibre optics) are cables that have up to hundreds of these glass fibres inside. Each fibre is only as thick as a human hair!²

‘A scientist is someone who has expert knowledge in a particular area of natural or physical science.’



‘Ideas do not always come in a flash but by diligent trial-and-error experiments that take time and thought.’

**Professor Sir Charles Kao
1933 - 2018**

▼ Each fibre optic is only as thick as a human hair.



[5] Nowadays, fibre optics are an important part of modern life. They are used for broadband internet, cable television, phone lines, computer networking and more! These cables are faster, more secure and more reliable than traditional copper cables when it comes to telecommunications. In fact, things like instant messaging, video-streaming and e-commerce (online shopping) would not be possible (or would be a lot slower) without fibre optics! Kao’s discovery has transformed the way the world communicates. We are now able to send huge amounts of information across the world almost instantly! This allows scientists around the world to exchange research and ideas. This can lead to new discoveries and inventions. It comes as no surprise that, in 2009, Charles Kao won a Nobel Prize in Physics for his groundbreaking research into how light can be transmitted through optical fibres for use in communication.³

Four Women Scientists Who Changed the World

[6] Did you know that many important scientific discoveries have been made by women? Today, more and more countries around the world have begun encouraging more women to pursue a career in STEM, and it is easy to see why! Here are four amazing female scientists whose discoveries changed the world for the better.⁴

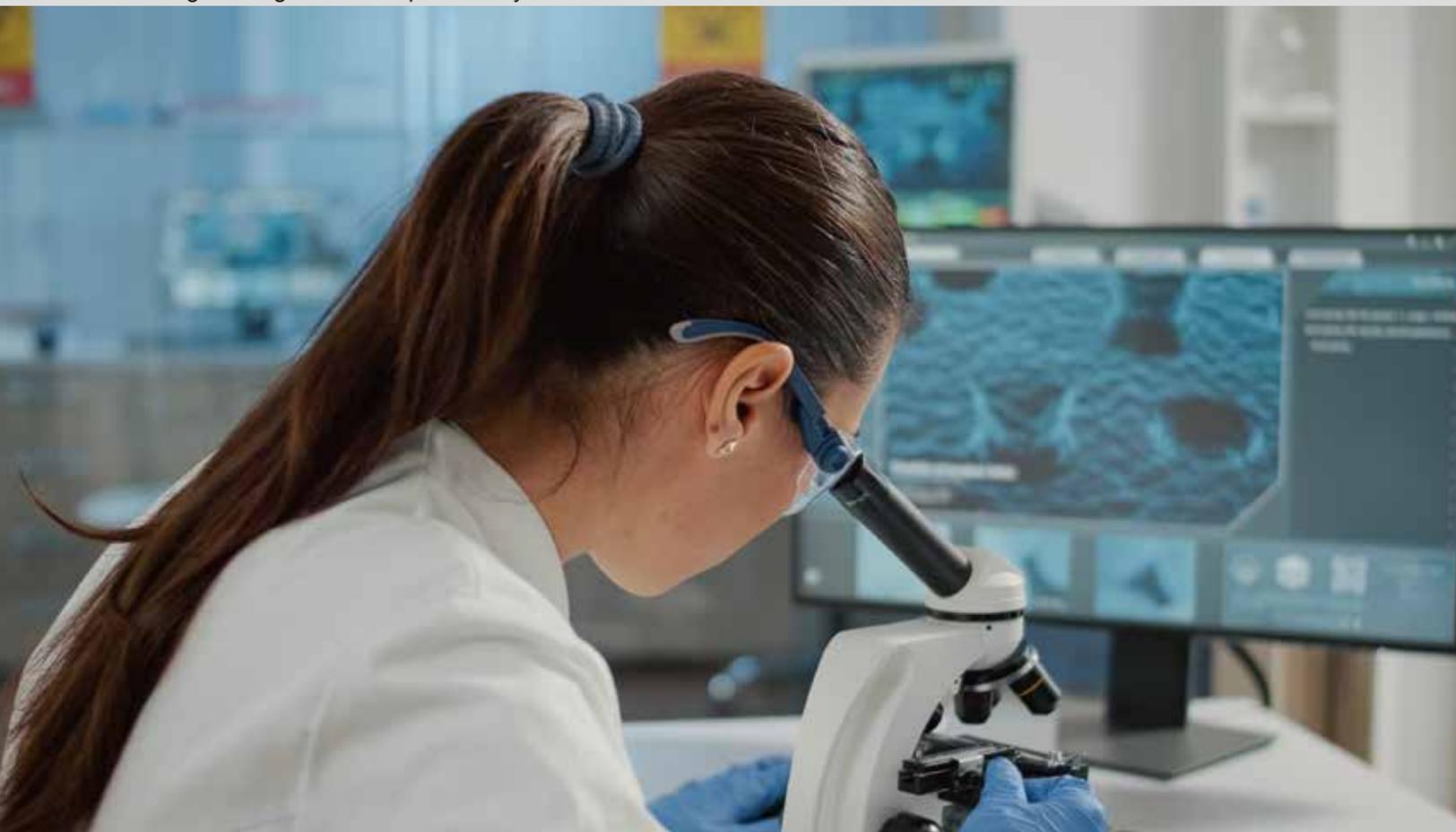
[7] In 2015, Tu Youyou became the first woman from China to win a Nobel Prize in any category. She was a chemist who was awarded a Nobel Prize in Physiology or Medicine for discovering a medicine used for the treatment of malaria. Malaria is a very dangerous disease, and millions of people have been saved thanks to her discovery!

[8] Chien-Shiung Wu was a nuclear physicist who helped to create the world's first nuclear weapon. She is also well known for the 'Wu experiment', which proved that what scientists used to think was a basic law of physics was wrong. Wu won the Wolf Prize in Physics in 1978.

[9] Vivian Yam Wing-wah is a Chinese chemist from Hong Kong who won the L'Oréal-UNESCO Awards for Women in Science in 2011. Her research focused on discovering more energy-efficient ways to create light. In fact, the display screens on devices like your mobile phones and laptops are all based on her work!

[10] Hedy Lamarr was an American actress and self-taught scientist who was born in Austria. Her work on radio signals has allowed us to develop wireless technology. Without her, there would be no bluetooth and no WiFi! Eight years after her death, Hedy Lamarr was added to the National Inventors Hall of Fame in 2014.

▼ Biologist using a microscope to study cells



Setting Children up for Success

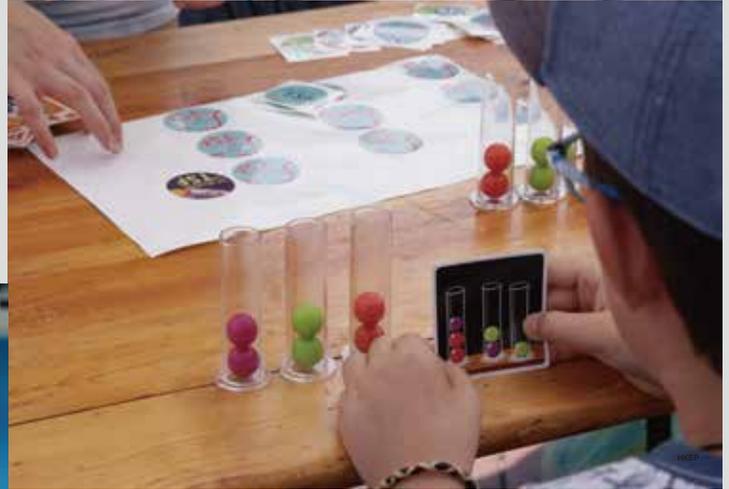
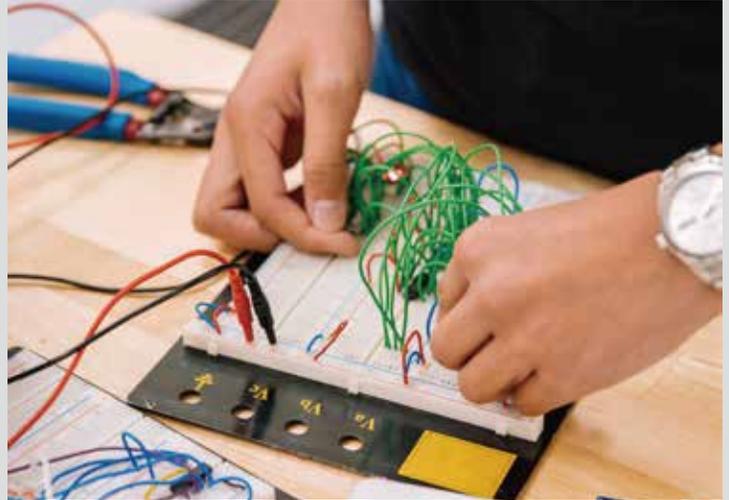
[11] The Chinese government knows that it is important to introduce STEM to children when they are still young. However, teaching children STEM isn't just about teaching Science, Technology, Engineering and Mathematics separately. STEM is not everyone's **cup of tea**. This means you need to inspire children by combining the four subjects in a fun, **hands-on** and exciting way.

▼ Students experimenting with a robot design



▲ Students working on a computer software project

▼ Students working on an engineering experiment



▲ Students working on a fun science project

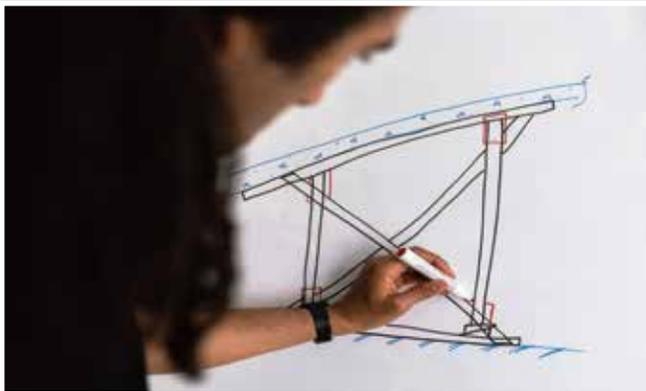
[12] One example could be students working on a project together. They identify a problem, come up with possible solutions, and then build or test something to see if their solutions were correct. By teaching STEM like this, we can help students to develop skills like problem-solving, critical-thinking and decision-making. Young children are always trying to understand the world around them. This makes it a good time to encourage their creativity and curiosity! It is important to realise that students do not always have to be 'right'; the key is to get them to **think outside the box!** In order to **set children on the path** for STEM success, the Ministry of Education officially included STEM as part of China's primary school education in 2017 for both public and private schools.⁵

STEM Is the Future

[13] The Chinese government has identified STEM education as an important driver for future economic growth (economic security). In the past, China's economy was based on producing large amounts of goods in its factories and exporting them to the rest of the world. However, China's focus right now is on changing the country into an advanced economy. This advanced economy will depend on talented individuals with high skills and knowledge. STEM is the future of our country. Science leads to the invention of new medicine. Advancements in technology and the internet have provided a lot of convenience for shoppers; we are able to use the internet to order fast food, buy movie tickets, and even pick our favourite seats in the cinema. Advanced engineering has allowed us to build longer and stronger bridges; this helps to cut down on travel time and can reduce fuel consumption and even reduce CO₂. Do you know what skills engineers use daily? It's mathematics! Even a small miscalculation could lead to disasters like collapsed buildings or bridges!

[14] National security domains are interwoven and affect each other. STEM can protect our country by developing new inventions and technology to protect our territory and communicate securely. It is an important part of protecting a country's science and technology and homeland security!

‘Students do not always have to be “right”; the key is to get them to think outside the box! STEM can help many industries develop and flourish!’



▲ Civil engineers working on construction projects

Reference

1. M. A. Shampo, R. A. Kyle, and D. P. Steensma, "Charles K. Kao—Father of Fiber Optics," *Mayo Clin. Proc.*, vol. 86, no. 8, p.e45, Aug 2011.
2. "What Is Optical Fiber Technology, and How Does It Work?," *Reliable Connectivity Solutions*, 2021.
3. J. Midwinter, "Sir Charles Kuen Kao," 2020.
4. J. Wong, "5 women scientists who changed the world," *South China Morning Post*, Hong Kong, 11 Feb 2019.
5. "China's STEM Education in Action: Observations, Initiatives and Reflections," *GET China Insights*, 2019.

Questions (14 marks)

- a. Which field of science did Charles Kao specialise in? (1 mark)
- A. Physics
 B. Chemistry
 C. Biology
 D. Mathematics
- A B C D
- b. According to the article, which of the following statements are correct? (1 mark)
- (1) An archaeologist studies cultures of the past.
 (2) Fibre optic cables are widely applied in telecommunications.
 (3) STEM has been included in China's primary school education.
 (4) No female scientist has ever won a Nobel Prize.
- A. (1) and (3) only
 B. (1), (2) and (3) only
 C. (2), (3) and (4) only
 D. All of the above
- A B C D
- c. Match the following female scientists with their achievements. (4 marks)
- | | | | | |
|-------------------------|---|--|---|--|
| (i) Vivian Yam Wing-wah | • | | • | A. Her work on radio signals helped to develop wireless technology. |
| (ii) Chien-Shiung Wu | • | | • | B. She worked on discovering more energy-efficient ways to create light. |
| (iii) Hedy Lamarr | • | | • | C. She discovered a medicine used for the treatment of malaria. |
| (iv) Tu Youyou | • | | • | D. She helped to create the world's first nuclear weapon. |

Essential Concepts and Terms

1. science and technology security 科技安全

Definition It refers to the security of science and technology itself and the technological support for safeguarding the security of related fields. Covering a variety of aspects such as technological personnel, facilities and equipment, scientific and technological activities and outcomes and the application of outcomes, science and technology security serves as a major supporting force and the technological foundation of national security.

2. STEM

Definition It stands for 'Science', 'Technology', 'Engineering' and 'Mathematics'. It focuses on the teaching of science and technology, and aims at nurturing scientists and technology-related experts.

English Corner

1. think outside the box (idiom) 打破常規地思考

Meaning to think in an original or creative way instead of the traditional or expected way
e.g. You need to **think outside the box** if you want to win the science fair.

2. cup of tea (noun) 喜歡的人或事

Meaning someone or something that someone really likes (usually used with 'not')
e.g. Swimming is not my **cup of tea**. (I do not like swimming.)

3. hands-on (adjective) 實際的

Meaning doing something rather than just talking about it
e.g. I got some **hands-on** computer training at school today.

4. set (someone) on the path (phrase) 使（某人）走上道路

Meaning to start someone on a journey towards something (figurative)
e.g. Studying hard at school **set** him **on the path** to success.

Glossary

advanced economy 發達經濟體	innovative 創新的
ancient ruins 古代遺跡	instant messaging 即時通訊
archaeologist 考古學家	invention 發明
astronomer 天文學家	malaria 瘧疾
biologist 生物學家	Mathematics 數學
broadband internet 寬頻互聯網	microbiologist 微生物學家
chemical reaction 化學反應	natural science 自然科學
chemist 化學家	nuclear weapon 核武器
critical-thinking 批判性思考	physical science 物理科學
decision-making 決策	physicist 物理學家
discovery 發現	problem-solving 解決問題
e-commerce 電子商務	Science 科學
engineer 工程師	science and technology security 科技安全
Engineering 工程	scientist 科學家
experiment 實驗	standard of living 生活水平
fibre optic cable 光纖電纜	Technology 科技
flourish 蓬勃發展	telecommunications 電訊
geologist 地質學家	telescope 望遠鏡
global warming 全球暖化	video-streaming 視訊串流
groundbreaking 開創性的	zoologist 動物學家