Introduction

About the Course

Light Up Science is a six-level bilingual science course for primary students, mapped against China's Science and English curricular standards. Each level is composed of two packages, A for the first semester, and B for the second semester. It aims to inspire an early passion for science and English in young students — the scientists, engineers and citizens of tomorrow. It helps you deliver a science learning experience to young children through English and Chinese in an interesting and effective way.

Course Objectives

The aim of this course is to guide students towards becoming global citizens who will have an open mind, be able to communicate science ideas in English, and become interested in scientific and technological innovation. To achieve this aim, course objectives are set from the following three aspects:

Develop students' scientific literacy

By the end of this course, students will:

- Form positive attitudes to science; become curious, inquisitive, cooperative and empirical; care for nature and living creatures; and become responsible for the community and the environment.
- Understand and engage in the process of inquiry.
- Understand the core science ideas and appreciate the relevance of science, technology and engineering to their daily lives.

Build students' intercultural communication skills

By the end of this course, students will:

- Develop intercultural communication interests and attitudes, and gain confidence to communicate science ideas in English.
- Master about 500 key words, with some sentence structures and discourse patterns in a science context; be able to use them for effective communication; and gain level-appropriate functional proficiency in listening, speaking, reading and writing.

Facilitate students' cognitive development

By the end of this course, students will:

- Develop thinking skills, such as observation, comparison, classification, how to conduct a fair test and control variables, problem solving, and critical and innovative thinking.
- Be able to reflect on how they learn.
- Be able to apply their thinking skills to other contexts.

Unique Features

This course has the following unique features:

- A dual-focused educational approach, integrating content and language learning, in keeping with the philosophy underpinning a Content and Language Integrated Learning (CLIL) course.
- A teaching approach to accelerate students' cognitive development by challenging students' current level of thinking, encouraging the social construction of knowledge and facilitating self-awareness as learners.
- A wide range of topics to expose students to the big ideas within areas of life science, physical science and earth and space science.
- An inquiry-based approach to science, helping students explore the natural world through guided inquiry, structured inquiry and open-ended inquiry.
- A range of tasks to develop design and technology skills as well as creativity and innovation, helping students appreciate the relevance of science, technology and engineering to everyday life.

Course Materials

Student's Book and CD-ROM e-book

The Student's Book is an e-pen edition which can be read with a VIATON reading pen. The point-to-read function and authentic British English pronunciation help to create a standardized learning environment, improve students' learning interest, and enhance their autonomous learning ability.

Each volume of the Student's Book consists of four units. Each unit contains several lessons that focus on different aspects of the main topic. (The special Design and Technology units at the end of each level have their own structure, explained below.) Each unit is introduced via an engaging cover page, on which questions, rhymes or riddles are supported by

colourful photographs. To start each lesson, we have included a **Stimulus Activity** which initiates thinking and sets the scene for the learning which follows. **Key Words** introduce the words that are relevant to the key concepts of the lesson. Each lesson is presented as a set of **Activities**, which offer a variety of engagement for learners, from inquiry-based to kinaesthetic learning, and from songs to art and craft. **Now I Know ...** at the end of each lesson gives a brief recap of the main ideas and concepts. **How I Know ...** provides students with the opportunity to reflect on their own learning progress. The statements describe ways of learning. Some, usually one for each lesson, of the statements will not apply to the lesson. We suggest that students read out the statements aloud with your help. Encourage students to identify ways of learning that apply to the lesson which they have just completed. **Let's Practise!** offers a more practical application of what students have learnt. **Find Out More!** encourages students to further their thinking about the topic. To conclude the unit, **Unit Review**, with its assessment tasks, revisits the main ideas and concepts of the lessons.

The **Design and Technology (D&T) units** focus on getting students to design and make items such as small model boats. Each D&T unit has three parts. **Make It** is where students are set a D&T task and given some instructions on how to complete it. In **Test It**, students have to test if their products have achieved the desired functions, and their designs may be scored based on performance against given indicators. In **Think Again**, students have an opportunity to reflect upon the process of designing and making something, and can decide upon ways their designs and products could have been improved.

The **Glossary** at the end of the book allows students to revisit all the Key Words they have learnt. The accompanying CD-ROM contains an e-book version of the Student's Book, allowing students to listen to and review any of the text and songs at will, and to personalize their learning with notes and links to online resources.

In the Student's Book, you will find E-bag and four student cartoon characters (Mary, Susan, Bob and Tom). The friendly E-bag character supports the role of the teacher by explaining scientific concepts, and warning students against possible dangers. Mary, Susan, Bob and Tom illustrate how to complete the activities, and sometimes expose students' preconceptions.

Teacher's Book and CD-ROMs

While the Student's Book will be the focus for your teaching, this Teacher's Book will enable you to plan activities, prepare relevant materials, guide learners, and intervene to shape and embed new learning. It will also help you address students' preconceptions and guide you through a young person's development of scientific understanding.

The Teacher's Book contains three parts. Part 1 is the **Teaching Notes** in English. Part 2

contains the **Chinese Translations** of the Teaching Notes. Part 3 contains the **Workbook Answer Key**. The start of each unit in the Teaching Notes informs you of what your students will have learnt by the end of the unit. There are **Science Objectives**, which tell you the science ideas, skills and attitudes that are important within the unit, and **Language Objectives**, which show you the vocabulary and sentence structures which we expect students to be able to use by the close of the unit. Students should be able to make some statements about science content (e.g. "The moon is round."), as well as some skills statements (e.g. "I use my eyes to see."). Following these objectives, the **Unit Overview** introduces you to the topics that will be covered. This section also highlights possible challenges you might face when teaching the unit, and how you may deal with them.

Each lesson then starts with **Objectives** and an **Overview**, focusing on the topics of individual lessons. Each activity is accompanied by useful teaching notes, with suggested alternative or extension activities to enrich students' learning experience and address learner diversity. Answer keys to activities are shown on the facsimiles of the Student's Book pages. The **Now I Know ...** section is translated into Chinese so that it may easily assist bilingual learners. The **Unit Review** also comes with teaching notes and answer keys. You may wish to supplement the questions with others of your own. It is certain that, as the unit closes, students will have asked, or will still be asking, many questions. Give them time to explore these questions in their groups. For the teacher, such dialogue is a very powerful opportunity for formative assessment. Following the Unit Review is a **References** section, which suggests useful online resources relevant to the unit.

Teachers are provided with two **CD-ROMs**. CD-ROM 1 contains teaching resources in the form of PowerPoint presentations for each lesson. CD-ROM 2 is an e-book version of the Student's Book providing a click-to-read function.

Teachers play an essential role in students' learning processes. As you know your students' abilities the best, you may choose to adapt some of the activities or create your own additional materials for a lesson or a test to suit their needs.

Workbook

Each Student's Book is accompanied by a Workbook to enable students to revise and consolidate the knowledge and skills gained during each lesson. Based closely on the lesson activities in the Student's Book, the Workbook is intended for self-study outside of class. The Workbook includes **Activities**, a **Practise the Words!** section, and a simple, attractively designed **Reading** section, through which students can gain confidence with simple science passages in English, and think further about some questions related to the scientific topics they have covered.

Materials Kit

Students are also provided with a Materials Kit, which enables them to perform hands-on activities in person, in pairs or in groups. The kit contains a guidebook and all the basic materials required for each activity.

Our Philosophy

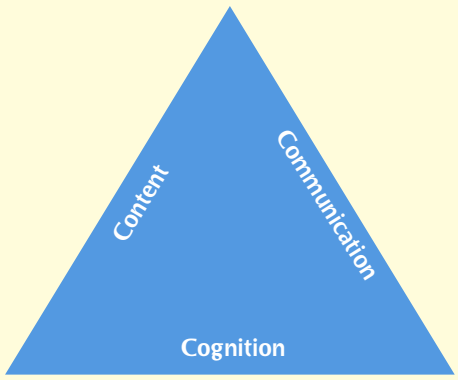
Content and Language Integrated Learning

Content and Language Integrated Learning (CLIL) was first defined by David Marsh in 1994:

"CLIL refers to a situation where subjects, or parts of subjects, are taught through a foreign language with dual-focused aims, namely the learning of content and the simultaneous learning of a foreign language."

CLIL is one innovative approach that has emerged to cater to the global age in which the world is interconnected in ways not seen before. It can offer a variety of benefits: It builds intercultural knowledge and understanding, develops intercultural communication skills, develops multilingual interests and attitudes, provides opportunities to study content through different perspectives, and increases learners' motivation and confidence in both the language and the subject being taught.

In *Light Up Science*, we have three focuses — content, communication and cognition. The first focus in the CLIL triad is science content, which provides the context of learning. Students will gain core science ideas and inquiry and design process skills, as well as scientific attitudes and values.



The CLIL Triad

Communication is the second focus. The English language, the tool of communication, aims to support content learning. Students do not learn English simply for the sake of language learning or for future use. It is students' desire to understand the content that motivates them to learn the language. They learn the English that they need for the sake of content learning, and put just-learnt language to immediate use while learning science content that is relevant to their lives. It is a just-in-time language learning approach. With *Light Up Science*, students will develop a science vocabulary, sentence structures and discourse patterns related to the science topics and gain the confidence to express science ideas in English.

Last but not least, the third focus is on the mental faculty of knowing, or cognition

(thinking). Thinking drives the learning process, whatever the subject is. CLIL is no exception: good CLIL practice is driven by cognition too. With *Light Up Science*, students will develop both lower- and higher-order thinking skills, and are always encouraged to reflect on their thinking processes ("metacognition").

Learning science and learning about science

The subject of science covers a particular body of knowledge — life science, physical science, and earth and space science. *Learning science* involves a learning journey moving from simple observation of features, phenomena and patterns to the building of concepts through dialogue and investigation, and from these concepts to appreciating the "big ideas" of science.

The big ideas of science have developed over a long time scale. New ideas build upon and challenge older ideas, and evidence from experiment and observation helps to shape new thinking. *Learning about science* is appreciating how new knowledge and understanding emerges through a process of inquiry. We want students to experience the process of inquiry and thereby understand how scientists build new knowledge in a systematic way. Students should not only "know some science" but also appreciate how science works.

To best understand how science works, students need to engage in their own inquiries. They need to be both hands-on and minds-on, and motivated to find out for themselves. Science inquiry usually involves proposing problems, making predictions, working out plans, collecting evidence through observation, measurement and experiment, interpreting results, drawing conclusions, sharing results, and evaluating and reflecting upon the inquiry process. It is a collaborative process where dialogue, shared ideas and the ability to listen, to think and to describe are critical. The language of science develops through talking, listening and thinking during the inquiry process. Understanding concepts and ideas, appreciating how science works and being confident to talk about it, read about it and engage in thinking about it is what is called "scientific literacy".

In *Light Up Science* we include activities which engage students in inquiry at three levels.

Inquiry Level	Description
Guided Inquiry	The direction of this type of inquiry is determined by the teacher. Guided inquiry can embrace a range of science skills and might be offered to students as a "Let's observe …" or "What can we discover about …?" activity.
Structured Inquiry	This is more focused and is about finding out in a methodical manner. It involves making predictions, gathering data and interpreting results. This might be offered to students as a "What happens if …?" or "Which is best for …?" activity.

Inquiry Level	Description
Open-ended Inquiry	This is more open-ended than a structured inquiry. It usually involves a fair test, managing variables and sharing results. This might be offered to students on a "Design your own way of finding out ..." basis.

Learning science also involves the development of attitudes such as an enquiring mind, an evidence-based attitude, care for living things, and a sense of responsibility for the environment.

With its variety of topics, its thoughtful and practical activities, and its engaging design, our course will offer your students an enjoyable learning experience which encompasses all essential aspects of learning science.

Cognitive Acceleration and metacognition

Teachers have the opportunity to reshape and accelerate learning. Learners construct their own interpretations of the world, and these personal interpretations, often called "alternative frameworks", have a significant influence on classroom learning. The process of reconstructing or reshaping personal learning through the exploration of key concepts, through skilled questioning, through group thinking and problem-solving tasks, is called "social constructivism". This process has helped shape the design of lessons and activities in *Light Up Science*. Articulating, listening and reshaping ideas is a social process. Learning is shaped by group interactions, by forming and reforming sentences which describe reasoning and reveal thinking. Within this social dialogue the learner is an active contributor, aware of their own contributions and their own thinking. This process is called "metacognition".

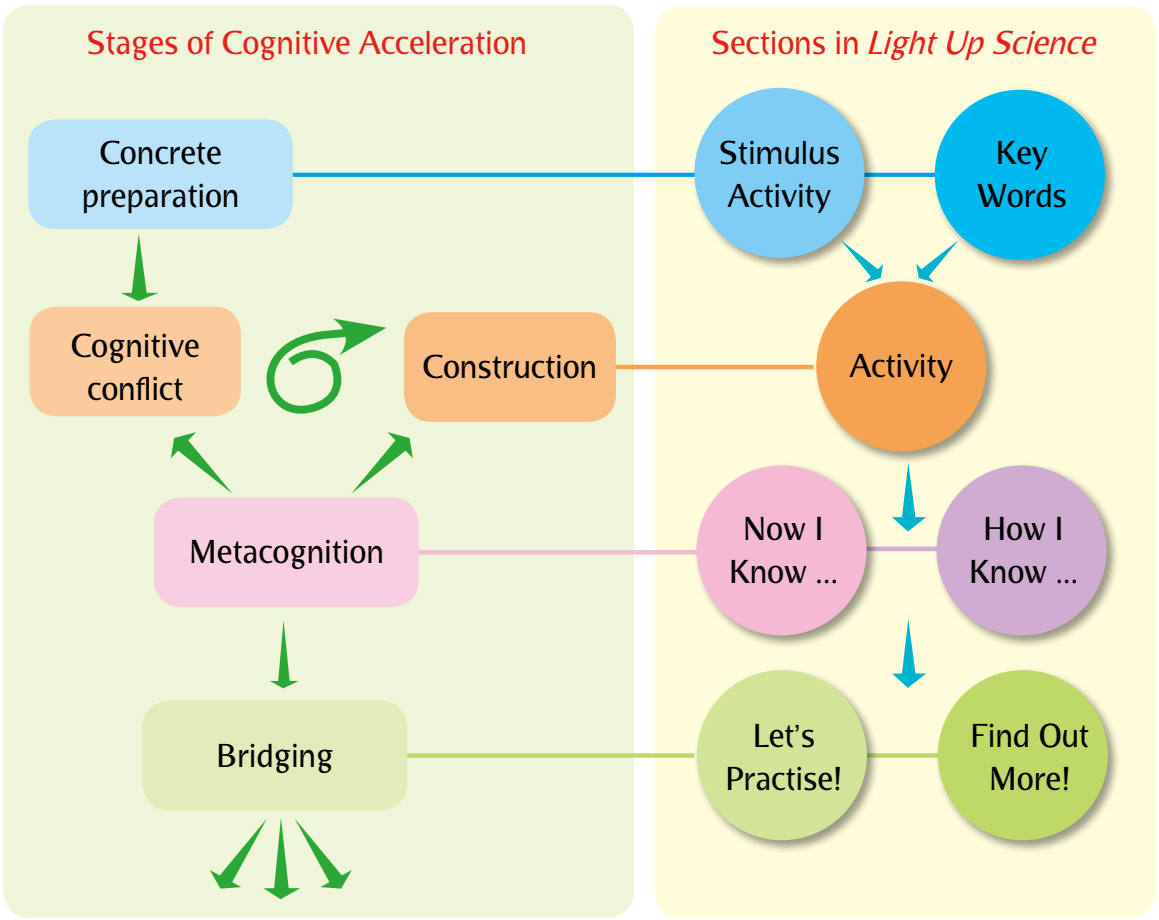
"Cognitive Acceleration" (CA) means the process of accelerating students' "natural" development process through different stages of thinking ability. First developed by Michael Shayer and Philip Adey at King's College, London, Cognitive Acceleration is a constructivist approach to learning and teaching and has its foundations in the ideas of Jean Piaget and Lev Vygotsky. Students are encouraged to be provided with cognitively stimulating experience, learn co-operatively (social construction of knowledge) and reflect on their own thinking and problem-solving processes (metacognition). Cognitive Acceleration has been applied in the UK and some other countries since the 1980s, and has been demonstrated to show positive effects on students' cognitive growth and academic performance.

Teachers, trained in the philosophy of CA, deliver a series of "thinking skills" lessons during which constructivist strategies such as group work, dialogue and metacognition play a part.

CA lessons run over five stages:

1. Concrete preparation, where the teacher sets the context, clarifies the terms of problems and introduces new words or equipment.
2. Cognitive conflict, where students encounter problems taking place within their "zone of proximal development" (ZPD) which cannot be easily solved by learners using their current level of thinking but which, with carefully structured help from an adult or more able peers, they can solve.
3. Construction, where students resolve cognitive conflict through inquiry and discussion either in pairs, small groups or as a whole class.
4. Metacognition, which means simply "thinking about your own thinking", where students reflect upon how they solved a problem, what they found difficult about it, what sort of reasoning they used, how they sought help and what sort of help they needed.
5. Bridging, where students apply their thinking to new contexts.

The sections of our course have been influenced by a thinking skills philosophy as shown in the following diagram:



All science lessons have their own unique character. Some follow the above scheme more closely than others. However, cognitive challenge is built into all lessons. This does not have to be cognitive conflict, but on occasions it is.

Assessment

Both teachers and learners need to know how learning is progressing. During teaching you will no doubt ask yourself questions such as: Are the key ideas emerging? What is happening to students' thinking? Are we ready to move on to the next stage? If not, where are the stumbling blocks?

Answers to these "real-time" questions need to emerge during the learning process so that you can act accordingly. Formative assessment helps you monitor students' progress as they learn. The course is designed to provide opportunities for formative assessment during lessons. There are group tasks during which you can listen to students' dialogue and opportunities where you can probe understanding through your own questions to individuals or to groups. Drawings and activities in Student's Book have been designed to offer first-hand evidence of learning. Effective formative assessment will tell you how well your students have been doing and where their challenges lie, and enable you to adjust your teaching accordingly. Feedback to learners on their achievements can provide motivation to learn more, to engage more and to ask more questions. Assessment can be a great booster for student confidence and positive attitudes towards learning.

Apart from formative assessment, we have provided you with summative assessment resources throughout the course. The Now I Know ..., Let's Practise! and Find Out More! sections tell you the most important learning outcomes for a lesson. Use these summaries to formulate your questions to students. Each unit closes with a Unit Review. You may use the Unit Review as a formal test, but also as an informal group task or whole-class focus for discussion. The Workbook is a useful tool for student self-assessment. You may decide to invite students to work in pairs to share their Workbook entries. Each semester closes with a summary assessment which covers key ideas from all four units. Any of these assessment tasks can be accompanied by student reflections about their own progress. They might want to write out some new targets for their own learning, or celebrate learning by writing a "note to self" congratulating themselves on their progress.

During periods of assessment you will want to ask yourself: "What am I looking for?" Be guided by the planned objectives for learning and ask yourself questions such as:

- Do the students understand the core ideas? Which ideas might need revisiting?

- Are they confident with learning through a process of inquiry? Can I see evidence of inquiry skills being used and developed?
- Do they display positive attitudes towards science? Is there evidence of motivation? Do they ask questions?
- Do they gain confidence in using English to communicate science ideas?
- Can they use appropriate words, sentence structures and discourse patterns?
- Are they self-aware? What do they say about their own learning?

A portfolio of achievement can be designed to include evidence covering all these elements. Creating a portfolio of achievement for each student can help teachers, students and parents monitor progress. Leave space for celebratory comments, reward stars and "must do" targets, but remember to give ownership and thereby responsibility for their portfolios to the students themselves.

Philip Adey Bob Kibble
Editors-in-chief for *Light Up Science*

简　介

关于课程

“科学”（*Light Up Science*）是参照我国的科学和英语双重课程标准，专为我国学生开发的学科・英语整合课程。本课程包括六个难度级别，每个级别分为 A、B 两个资源包，A 适用于上学期，B 适用于下学期。青少年学生将成为未来的科学家、工程师和社会公民。本课程的目标是激发他们早期对科学和英语的兴趣，帮助教师以一种既有趣又有效的方式引导学生用英语和汉语学习科学。

课程目标

本课程的目标是使学生未来成为具有开放心态、能够用英语交流科学观点、对科技创新充满兴趣的世界公民。具体的目标包括三个方面：

培养学生的科学素养

通过本课程的学习，学生将：

- 形成对科学的积极态度；充满好奇心、乐于探索、愿意合作、实事求是；关爱自然，珍爱生命；对社会和环境富有责任感。
- 理解并参与到探究过程中。
- 理解科学领域中的核心概念，理解科学、技术以及工程与日常生活的密切联系。

发展学生的跨文化交流能力

通过本课程的学习，学生将：

- 形成跨文化交流的兴趣和意愿，建立用英语交流科学观点的信心。
- 掌握大约 500 个关键词以及在科学语境中的一些句型和话语模式，并能运用它们进行有效的交流；在听、说、读、写方面达到一定的熟练程度。

加速学生的认知发展

通过本课程的学习，学生将：

- 初步掌握科学的思维方法，例如：观察、比较、分类、公平实验、控制变量、问

题解决能力以及批判性思维和创造性思维。

- 能够反思自己的学习过程。
- 能够将学到的思维方法运用到其他情境中。

课程特色

本课程有如下特色：

- 根据内容与语言整合学习（CLIL）的理念，采取双聚焦的教学模式，将内容学习与语言学习结合起来。
- 运用加速学生认知发展的教学方法，注重挑战学生现有的思维水平，促进知识的社会建构，促进学习者的自我意识的发展。
- 提供了广泛的话题，学生将接触生命科学、物质科学、地球与空间科学领域的核心概念。
- 倡导探究式学习，学生将在引导式探究、结构式探究和开放式探究活动中探索自然界。
- 特别设有“设计与技术”单元，培养学生的设计与动手能力、创造力和创新能力，帮助学生理解科学、技术、工程与日常生活的联系。

课程材料

学生用书及配套 CD-ROM 电子书

学生用书为点读版，可用外研通点读笔进行英文的点读。即点即读的学习模式，原汁原味的英式发音，有助于提高学生的学习兴趣，增强自主学习能力，让他们轻松融入标准、规范的学习环境中。

每册学生用书包括四个单元。每个单元围绕核心话题分为若干课。（每个级别的最后一个单元是设计与技术单元，结构与其他单元不同，我们会在后面加以说明。）每个单元一开始是生动的篇章页，上面有问题、小诗或谜语，并配有彩色的图片。每课一开始是**导入活动**，旨在激发学生思考，为后续的学习作铺垫。**关键词**列出了与每课核心概念相关的词汇。然后是一系列的**活动**，包括探究活动、动觉学习活动、唱歌和手工制作等多种形式，吸引学生参与其中。每课的最后包括：**现在我知道……**帮助学生回顾每课的核心概念；**我是如何知道的……**为学生提供了反思自己学习过程的机会（书中的句子

描述的是学习方法。一般而言，每课有一句话不符合该课的学习情况。我们建议学生在教师的指导下大声朗读这些句子。然后，教师应鼓励学生找出刚刚结束的课程中使用的学习方法。）；**让我们练习吧！**让学生将所学知识用于实践；**发现更多！**鼓励学生围绕主题进行进一步的思考。作为单元的结束，**单元复习**包含了一系列评价任务，引导学生回顾该单元中的主要内容和核心概念。

在**设计与技术单元**中，学生将设计并制作一些小物品，如小船模型。每个设计与技术单元包括三部分：在**制作**部分，我们给学生设定一个任务，并指导学生完成该任务；在**测试**部分，学生要检验他们的作品是否达到了预期的目标，他们的设计还可以基于给定的标准进行评分；在**再想一想**部分，学生将有机会回顾设计和制作的过程，并考虑如何改进自己的设计和作品。

学生用书最后的**词汇表**帮助学生复习他们所学过的所有关键词。配套的 CD-ROM 光盘包含学生用书电子书，能够让学生随时听并复习课文、歌曲，同时通过笔记和网上资源链接进行个性化学习。

在学生用书中，还有电子书包以及四个卡通人物（玛丽、苏珊、鲍勃和汤姆）形象。电子书包形象亲切、和善，它扮演着小教师的角色，给学生解释科学概念，并警告学生远离可能发生的危险。玛丽、苏珊、鲍勃和汤姆将说明如何完成活动，并引发学生思考，帮助教师发现学生的前概念。

教师用书及配套 CD–ROM 光盘

学生用书是教师教学时的重要依据，教师用书可以帮助教师设计教学活动，准备相关材料，引导学生学习，并对学生的学习过程进行有效的干预，从而帮助学生学习新知识。教师用书还将帮助教师纠正学生前概念中的错误成分，引导学生逐步形成对科学的正确理解。

教师用书包括三部分：第一部分是英文版的**教学建议**；第二部分是教学建议的**中文翻译**；第三部分是**活动用书答案**。在教学建议中，每一单元一开始会告诉教师单元的教学目标，包括科学目标和语言目标。**科学目标**列出了单元中重要的科学概念、科学技能和科学态度；**语言目标**列出了在完成各单元的学习后，我们希望学生能够使用的词汇和句型。学生要能够描述科学内容（如“月亮是圆的。”），并陈述获得的科学技能（如“我用眼睛看。”）。在科学目标和语言目标之后，**单元概述**介绍了各单元将讨论的话题，并着重说明了教师在教学过程中可能遇到的问题以及解决的方法。

每一课中会有具体的**教学目标**和**概述**。每个活动都配有有用的教学建议，并提供了一些备选活动和拓展活动，以丰富学生的学习体验，适应不同学生多样化的需求。教师用书中还提供了学生用书的缩略图，上面给出了活动的答案。**现在我知道……**已翻译成中文，以方便双语学习者使用。**单元复习**也配有教学建议和参考答案。教师也可以补充上一些自己设计的问题。在各单元结束时，学生肯定已经提出了很多问题，或者仍在提出新的问题，教师应给予他们足够的时间进行小组讨论。对教师来说，学生间的意见交换为形成性评价提供了很好的机会。在单元复习之后是**参考网址**，该部分提供了与各单元话题相关的、有用的网上资源。

教师用书配有两张 CD–ROM 光盘。CD-ROM 1 包含的教学资源是每课的演示文稿。CD-ROM 2 是学生用书的电子书，具备点读功能。

教师在学生的学习过程中扮演了非常重要的角色。因为教师最了解学生的能力，所以可以改编一些活动甚至自己设计一些额外的活动或测试题来满足学生的需求。

活动用书

每册学生用书都配有一册活动用书，用来帮助学生复习并巩固每课所学的知识和技能。活动用书是紧密围绕学生用书中的活动设计的，可供学生课外自学。活动用书包括**活动**、**词汇练习**和**阅读短文**三部分。其中，阅读短文简单易懂、生动有趣，可以增强学生阅读简单英语科学短文的信心，并使学生进一步思考相关的科学问题。

活动材料包

每册学生用书都配有活动材料包，支持学生开展动手实践活动。活动材料包中有一本指导手册和各个活动所需要的基本材料。

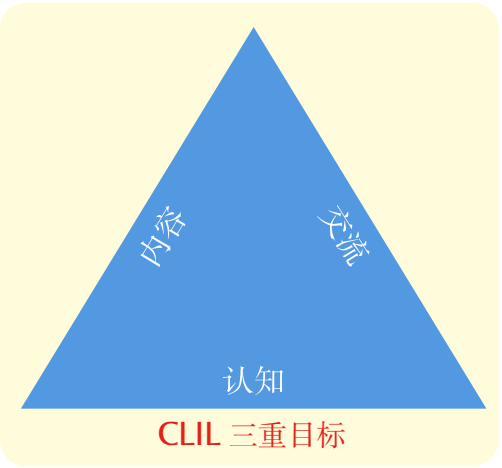
课程理念

内容与语言整合学习

内容与语言整合学习（简称 CLIL）的理念是由戴维·马什在 1994 年首次提出的。他说："CLIL 指的是通过一门外语学习一门学科的全部或部分内容。这个教学过程有双重目标，学生既学习学科内容，又同时学习这门外语。"

当今世界以前所未有的方式相互联系。CLIL 作为一种创新的教学方法迎合了这个全球化的时代。CLIL 教学法可以带来许多好处：它可以帮助学生建构跨文化交流的知识与

理解，发展学生跨文化交流的技能，培养学生对多语言学习的兴趣和态度，为学生提供多视角学习学科内容的机会，增强学生对语言和学科学习的积极性与自信心。



CLIL 三重目标

在本课程中，我们设计了三重目标，包括内容、交流与认知。第一重目标是科学内容，它为学生提供了学习材料。学生将学习科学中的核心概念、科学探究与设计过程中所需的重要技能，并形成正确的科学态度与价值观。

第二重目标是交流。英语作为一种交流的工具，旨在帮助学生完成科学内容的学习。学生学习英语不再仅仅是为了学习语言以及日后的使用，而且是出于自身想要理解科学内容的愿望。他们为了学习科学内容而学习所需的英语，并将刚刚学到的英语立即应用到与生活相关的科学知识的学习过程中。这是一种即学即用的语言学习策略。通过学习本课程，学生将初步掌握一些科学词汇、与科学话题相关的句型及话语模式，并建立起用英语表达科学观点的自信心。

第三重目标是认知（思维能力），它是智力的核心。无论学习什么学科，思维总是推动着学习的过程。CLIL 教学法也不例外：好的 CLIL 教学实践也是由认知推动的。通过学习本课程，学生将学习低阶思维方法和高阶思维方法，同时学会反思自己的思维过程（“元认知”）。

学习科学，理解科学过程

科学这门学科涵盖了一个专门的知识体系，它包括生命科学、物质科学以及地球与空间科学。“学习科学”从观察简单的特征、现象和模式开始，然后到通过讨论和探究来建构一些概念，最后到理解科学领域中的“大概念”。

科学领域中的大概念都是经过长时间的积淀形成的。新概念建立在旧概念的基础之上，并向旧概念发起挑战，通过实验、观察等方式获得的各种证据促进新思想的形成。“理解科学过程”就是要领会如何通过科学探究的过程发现新知识、形成新认识。我们希望学生体验探究的过程，由此了解科学家是如何系统地构建新知识体系的。对于科学，学生不仅应该“知道一些科学知识”，还应该理解科学研究是如何进行的。

为了更好地理解科学研究是如何进行的，学生需要参与到探究过程中。为此，学生

必须手脑并用，并积极寻找答案。科学探究的过程一般包括：提出问题，作出预测，制订计划，通过观察、测量和实验收集证据，分析结果，得出结论，分享结果，以及评价和反思整个探究过程。这是一个相互协作的过程，在此过程中，对话、交流以及倾听、思考和描述的能力十分重要。通过科学探究过程中的交流、倾听和思考，学生的科学语言也随之发展起来。所谓“科学素养”，包括理解科学概念和科学思想，领会科学探究过程，以及充满自信地讨论、思考科学话题，阅读科学文章。

在本课程中，我们设计了以下三个层次的探究活动，学生可以参与其中。

探究的层次	描述
引导式探究	这一层次的探究活动是在教师的引导下进行的，其中包含一系列科学技能的培养。活动一般以“让我们观察……”或者“关于……我们能发现什么呢？”的形式呈现。
结构式探究	这一层次的探究活动更加聚焦于某个问题，需要按照系统的方法进行，包括作出预测、收集数据和阐释结果。活动一般以“如果……会发生什么？”或者“……的最佳选择是……”的形式呈现。
开放式探究	比起结构式探究，这一层次的探究活动更加开放。通常包含公平测试、控制变量和分享结果。活动一般以“设计自己的研究方案，找出……的答案”的形式呈现。

“学习科学”还包括形成对科学的积极态度，比如乐于探究的科学态度、基于实证的科学态度、对生命的关爱和对环境的责任感。

本课程话题丰富，活动引发思考、联系现实生活，版式生动活泼，将为学生提供一次轻松愉快、全方位的科学学习体验。

认知加速与元认知

教师有机会重塑并加速学生的学习过程。学生会建构他们自己对世界的诠释，这些个人诠释又被称作“替代概念框架”，通常对课堂学习有着重大影响。通过对核心概念的探究、教师富有技巧性的提问、小组思考和解决问题的活动，来重建或重塑个人学习的过程，就是“社会建构主义”。基于这个理念设计了本课程。阐明想法、倾听他人的想法并重塑个人的想法是一个社会建构的过程。团队的互动以及组织和改进语言来描述推理过程、揭示思维过程，都会影响学习的过程。在这种社会性的对话中，学生意识到

自己的贡献和思维过程，是积极的贡献者，这个过程就叫做“元认知”。

“认知加速”是指加速学生在不同思维能力阶段“自然”的发展进程，最早由伦敦国王学院的迈克尔·沙耶和菲利普·阿迪提出。该理论是一种建构主义教学观，以让·皮亚杰和列夫·维果斯基的观点为基础，注重提供挑战学生当前认知水平的活动，鼓励合作学习（知识的社会建构），鼓励反思思维过程和解决问题的过程（元认知）。从 20 世纪 80 年代起，英国和其他一些国家开始在教学中运用认知加速理论，经实践证实其对学生的认知发展和学业成绩有积极的作用。

教师在接受认知加速理论的培训后，教授一系列“思维技能”课程，并在此过程中采用建构主义的教学策略，如小组合作、对话和元认知。认知加速课程一般包括以下五个阶段：

1. 具体准备。在本阶段，教师将设置情境，阐明问题中涉及的术语，介绍新词汇或新设备。

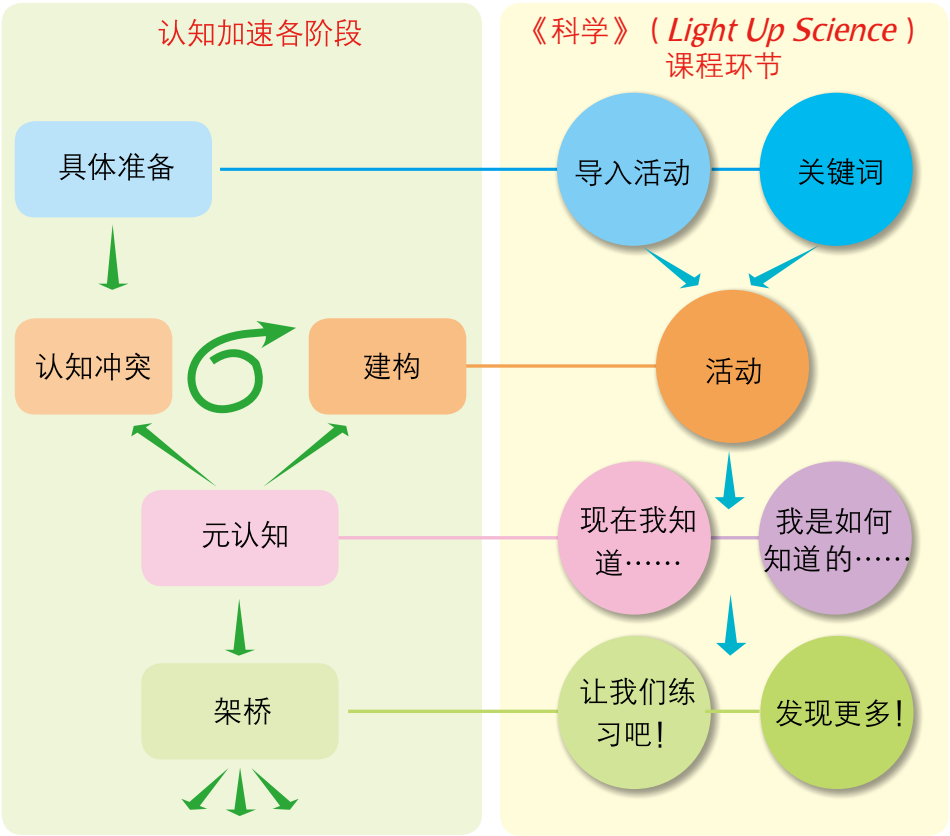
2. 认知冲突。在本阶段，学生将遇到在他们“最近发展区”内的问题，这些问题靠他们现有的思维水平不能轻易地解决，但在成年人或更有能力的同龄人的细心引导下，他们可以解决这些问题。

3. 建构。在本阶段，学生通过以两人、小组或整个班级的探究和讨论来解决认知冲突。

4. 元认知，简单地说就是“对自己思维过程的思考”。在本阶段，学生将反思自己是如何解决问题的，在解决问题的过程中遇到了哪些困难，采用了哪种推理方法，是如何寻求帮助的，以及需要什么样的帮助等。

5. 架桥。在本阶段，学生将学到的思维方法运用到新的问题情境中去。

本课程在设计课程环节时，参考了认知加速理论，如下图所示：



在本课程中，每一课的设计都有各自的独特之处。虽然不是所有的课都与上述认知加速的阶段完全吻合，但是在每一课中，我们都设计了对学生认知的挑战，但不是所有的认知挑战都是认知冲突。

评价

无论是教师还是学生都需要了解学习的进展情况。毫无疑问，在教学过程中教师会问自己一些问题，比如：逐步地呈现出核心概念了吗？学生正在想什么？是否可以进入下一阶段的教学？如果不行，那么障碍在哪里？

对于这些“实时”的问题，教师需要在教学过程中找出答案，并采取相应的对策。形成性评价有助于教师监控学生学习的进展情况。在设计本课程时，我们提供了一些进行形成性评价的机会。在进行小组活动时，教师可以倾听学生的对话，还可以向个人或小组提问来摸清学生的理解情况。学生的图画及学生用书中的其他活动直接地反映了学生的学习情况。有效的形成性评价能帮助教师了解学生的学习效果以及存在的困难，使教师能够对教学作出相应的调整。对学生学习成果进行反馈能够激励他们进一步学习，参与更多的活动，提出更多的问题。这样的评价会大大提升学生的自信心，有助于帮助他们形成正确的学习态度。

除了形成性评价，课程中还贯穿有终结性评价的资源。**现在我知道……**、**让我们练习吧！**与**发现更多！**环节会告诉教师在每一课中学生最重要的学习成果。教师可以利用这些总结性活动向学生提出问题。每个单元结束时有单元复习，教师可以用作正式的测验，也可以用作非正式的小组作业或全班讨论的话题。活动用书是很实用的学生自我评价工具。教师可以请学生两人一组，交流他们的答案。每个学期期末还会有一个终结性评价，其中包含对该学期四个单元的核心概念的考查。所有这些评价都会伴随着学生对自己学习进展的反思。学生可能会写下自己新的学习目标，或者写一张“给自己的便条”来庆祝自己取得的进步。

在评价的不同阶段，教师可能会问自己：“我要找什么学习证据？”教师可以根据预定的教学目标反问自己这样的问题：

- 学生是否理解了核心概念？哪些概念需要再回顾一下？
- 在探究过程中，学生是否对学习充满了自信？我能看到学生使用并提高探究技能的证据吗？
- 学生对科学是否表现出了积极的态度？有没有他们积极参与的证据？他们提出问题了吗？
- 学生是否建立起用英语交流科学观点的信心？
- 学生能否使用恰当的词汇、句型以及话语模式？
- 学生对学习是否有正确的自我意识？他们如何评价自己的学习过程？

教师可以设计档案袋，记录学生在以上各个方面的学习成果。它可以帮助教师、学生和家长跟踪学生取得的进步。档案中应包括赞赏性评语、奖励星以及“必须掌握”的目标，但要记住，让学生自己保管档案袋，这样他们才会对自己的档案负责。

菲利普·阿迪

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