

CLIL in English Technology and the Society

CLILで学ぶ工学と社会

by

Shigeru Sasajima

Masayuki Takahashi

Yuko Uesugi

Kumiko Okazaki

Keisuke Tanino

Taichi Kawakami

Chiari Isami

Brian Shaw

Aleksandra Zaparucha



Narum-do

まえがき

学習者へ

本教科書は、CLIL (Content and Language Integrated Learning) (内容と言語を統合した学習) の考え方をもとにした英語の理解と実践を支援します。「英語を勉強する」という思い込みは少し脇に置いて、英語で「工学と社会」を思考しましょう。また、工学 (technology) という内容 (content) を、私たちの社会環境 (contexts) で、コミュニケーション (communication) として必要な英語 (English) で理解し、英語を使って学ぶことを目的としています。

英語の単語をおぼえ、アメリカ人のように発音できるように練習し、正しい文法を学び、正確に使えるように読み・書きを中心に学習し、それと同じように聞き・話すためにテストを受け、資格を得る。そのような実際の英語の運用とは少しかけ離れた学習活動とは縁を切って、工学という分野で英語を通してどのような知識を得て、それをどのように使って、世界中の工学に携わる人と知識や技能を共有するかを、この教科書を通じて考えてください。そのためには、文化と文化の関係性の理解 (intercultural awareness) が必要です。

工学は知識だけでは意味がありません。社会と強くかかわっています。その社会は日本語だけの社会ではほぼ意味がないでしょう。英語は必須です。それも、世界中で使われる英語 (ELF: English as a Lingua Franca) のコミュニケーション力が必要です。工学に興味があり、工学の分野に進む人にとっては、それはそれほどむずかしいことではありません。そのために少しでも寄与できたら幸いです。

先生へ

大学工学部、高専、工業高校などを対象として編纂してありますが、あくまで教材です。担当の先生の裁量で工夫して扱ってください。Unit は順番に扱う必要はありません。学習者の興味を優先して、幅を広げてください。さらに、教科書をすべて学ぶ必要はありません。まずは学びを楽しむことです。テストや活動については補助教材をつけますが、適宜利用してください。

CLIL について

CLIL は決して特別な学習法でも学習指導でもありません。工学という内容を英語と日本語で理解し、英語でコミュニケーションしようとする活動を後押しすることを目的としています。そのために、学習者自身が目標を持ち、ゴールを想定し、工学を英語で理解し、その知識を英語で活用できるようにプロセスとして CLIL を考えてください。実験や試作と同様に、失敗の積み重ねが成功への一歩です。CLIL は、そのための統合学習です。工学への興味があれば、英語は自然に身につきます。失敗を楽しみましょう。

著者一同

本教科書を活用する学習者の学び方について

扱っている内容は、工学の一般的な内容です。専門的には物足りないかもしれません。それぞれ自主的にインターネットなどで検索し自分の専門分野について深く学んでください。CLIL の大きな特徴は自律学習 (learner autonomy) です。与えられた知識や英語活動をただ学んでいるだけでは、CLIL の大きな特徴となっている次の「4つのC(4Cs)」を生かすことができません。

内容 (Content) — 工学のおもしろさに気づく

思考 (Cognition) — 工学を英語と関連し工夫する

コミュニケーション (Communication) — 工学の話題を英語で伝え合う

文化 (Culture) — 工学と社会を英語と日本語でふりかえる

上記の CLIL の特徴を生かすには多様性と柔軟性がカギです。「学習はかくあるべき」はやめましょう。知識や技能を楽しむこと、英語はただの道具と割り切ること、自分にとって大切なことは何かが分かれば、CLIL は自然に理解できます。

上記のことを達成するために、各 Unit の構成は次のようになっています。

1. *CLIL attainment target* (学習目標)

2. *Introduction* (導入)

Practice 1 Listen and check your understanding (リスニング)

Practice 2 Read and check your understanding (リーディング)

Practice 3 Talk In pairs (英語で話す)

3. *Topic 1* (工学の話題1)

Practice 4 (Reading question) (読むポイント)

4. *Text summarization* (要約のしかた)

Practice 5 Summary of Topic 1 Receipt it (要約の暗唱)

Practice 6 Read and summary (要約する)

5. *Topic 2* (工学の話題2)

Practice 7 (Discussion) (内容を英語で話し合う)

6. *Understanding key terms* (話題の重要語句)

Practice 8 (Discussion) (内容を英語で話し合う)

7. *Learning outcomes* (学習成果)

Self-assessment (自己評価)

Practice 9 A summary of learning (学習のまとめ)

教科書内容は、できる限り英語で工学を学ぶ人に役立つように工夫しました。しかし、物足りないところがあると思います。興味のあることは、ぜひ自分なりに深く追求してください。CLIL はそれを応援します。

Unit 1 7
 Artificial intelligence (AI): present and future

Unit 2 13
 3D printing: technology that makes our life more comfortable

Unit 3 19
 Power electronics supporting our life

Technology column 1 25
 A history of engineering

Unit 4 27
 Eco-housing for a better life

Unit 5 33
 Flow and the energy: fluid dynamics is useful in our life

Unit 6 39
 Electric vehicles (EVs): technology for assisting us

Technology column 2 45
 Saving energy

Unit 7 47
 Rescue robots as substitutes in danger

Unit 8 53
 Nanotechnology to change our life

Unit 9 59
 The hydrogen fuel cell train

Technology column 3 65
 Some issues of IoT

Unit 10 67
 Protein: research expands to outer space

Unit 11 73
 Shifting to renewable energy

Unit 12 79
 Nature learning: engineers look to the natural world

Technology column 4 85
 Withdrawing water from the air

Unit 1

Artificial intelligence (AI): present and future



AIの現在と未来

1. CLIL attainment target この課の学習目標を確認しよう

- | | |
|--|----------|
| 1. I can listen to and read what artificial intelligence (AI) is. | 聞く・読む技能 |
| 2. I can speak and write about how AI is used in our daily life. | 話す・書く技能 |
| 3. I can understand the ideas and problems about AI. | 関連の内容の理解 |

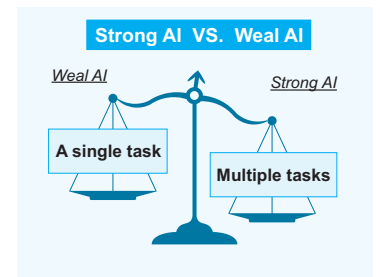
2. Introduction What is AI? AIとは何か?

Practice 1 Listen and check your understanding 聞き取ってみよう 02

- Which computer language is Takashi going to study?
 - Java
 - Python
 - C#
- How did Takashi get to know about AI research?
 - He read books.
 - He googled it.
 - He asked AI.

Practice 2 Read and check your understanding 情報を理解しよう 03

There are two types of AI – weak AI and strong AI. Weak AI refers to systems that can solve a limited range of problems by performing a pre-defined set of functions. Virtual personal assistants, such as Apple’s Siri and Amazon’s Alexa, are examples of weak AI. Strong AI refers to systems that can think and perform complex tasks on their own, similar to human beings. Such systems can “think for themselves” and thus, can find **solutions** to unfamiliar tasks without human **intervention**. Although strong AI sometimes appears in science fiction movies, it currently remains a theoretical concept. As research and development continues to advance, strong AI may eventually emerge.



Practice 3 Talk in pairs 内容を確認して、英語でおしゃべりしよう

What is the difference between weak AI and strong AI? Where is AI used around you?

- e.g. A: Do you know the difference between weak AI and strong AI?
 B: Yes. It’s easy. The systems are different. Do you know where AI is used?
 A: Yes. AI is used in lots of places.

CLIL in English
Technology and the Society

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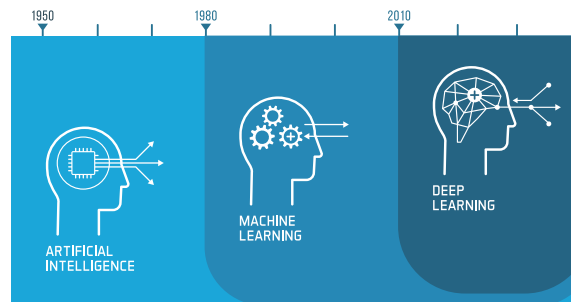
Shigeru Sasajima
Masayuki Takahashi
Yuko Uesugi
Kumiko Okazaki
Keisuke Tanino
Taichi Kawakami
Chiari Isami
Brian Shaw
Aleksandra Zaparucha
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3. Topic 1 AI as a savior for the future AIは救世主 04

Practice 4 Do you think AI can be a savior for our future life? AIは救世主ですか

- AI can be a savior for the future. Some people may think that the development of AI is a big threat to humans. They worry about AI's potential to **take over** jobs currently performed by human workers. However, such a view may be too pessimistic, since it fails to see the positive impacts that AI will have on future society.
- A declining **birthrate** and an **aging** population may result in worker shortages in the future, especially in Japan. AI can help **compensate for** a shortage of workers by **automatically operating machinery and equipment**.
- Human beings and AI should create a **symbiotic relationship**. AI should not be viewed as a threat to human societies. **On the contrary**, AI should be accepted for its potential to solve social problems and prolong human life through improved health and **medical care**.
- It is important to know how to use AI, machine learning, and deep learning. AI also includes machine learning and deep learning. These two ways of learning are part of AI.
- Machine learning refers to efforts to teach machines or computers to learn the way human beings do. It uses computer algorithms and statistical models to analyze data and **predict outcomes**.
- Deep learning is considered as part of machine learning. Moreover, it is gaining much attention due to its **supremacy** in terms of accuracy when it is trained with huge data. Deep learning can be used for many tasks such as understanding text documents and **distinguishing** people. Also, it is utilized in driverless cars and **speech recognition** systems.
- It is necessary to do more research on AI for the benefit of society. Since AI aspires to endow machines with abilities that replicate or exceed those of humans, research that helps us better understand how humans perform complex tasks can greatly aid the development of AI.



4. Text summarization How to make a summary 必要な情報のまとめ方

Practice 5 Summary of Topic 1 Recite it Topic 1 (前ページ) のまとめ 暗唱しよう

- AI can be a savior for the future.
- A declining birthrate and an aging population may result in worker shortages.
- Humans and AI should create a symbiotic relationship.
- It is important to know how to use AI, machine learning, and deep learning.
- Machine learning teaches machines or computers to learn the way human beings do.
- Deep learning can be considered as part of machine learning.
- It is necessary to do a lot more research on AI for the benefit of society.

Practice 6 Read and summarize 読んで内容を把握してサマリーを作成しよう  05

Alan Turing was a British **mathematician** and a founding father of the theory and development of AI. He invented the Turing test to determine if a machine could exhibit intelligent behavior equivalent to, or indistinguishable from, that of a human being. The test is designed to assess whether a machine can think or not.

The IBM supercomputer, Deep Blue, captured the world's imagination in 1997 when it defeated Garry Kasparov, the world's greatest chess champion at that time. The six-game match lasted several days, and Deep Blue had two wins, one defeat, and three draws.

An Expert System is a type of AI system designed to display and imitate aspects of **rational behavior**. Expert Systems are widely used in commercial and industrial settings, such as medicine, finance, **manufacturing**, sales, and video games.

Meta (or Facebook) and Twitter are two big companies that use AI to send users the right message at the right time. For example, Facebook has a function to introduce users who may somehow be connected.

In 1999, Sony released its first version of AIBO – a pet robot that people could play with. AIBO could express emotions and identify its owner. It was one of the first AI robots.

Complete the summary 適切な語を入れてサマリーを完成しよう

Alan Turing was a () father of the theory and development of (). The IBM supercomputer, **Deep Blue**, () the world's imagination in 1997. **An Expert System** is designed to display and imitate aspects of () behavior. **Meta (or Facebook)** and **Twitter** are two big companies that use AI to send users the right () at the right (). In 1999, () released its first version of **AIBO**.

Research What are you interested in when reading this passage? Choose one and do research.

5. Topic 2 The singularity in AI AIのシンギュラリティ(特異点)



Practice 7 The singularity in AI is a point at which AI can learn and improve itself faster than humans. Do you think it is possible? Discuss whether or not AI will surpass human intelligence. AIは人間の知性を超えますか?

AI will bring about the singularity. Have you ever heard of the term ‘singularity’? According to Dictionary.com, singularity is defined as ‘the state, fact, or quality of being singular.’

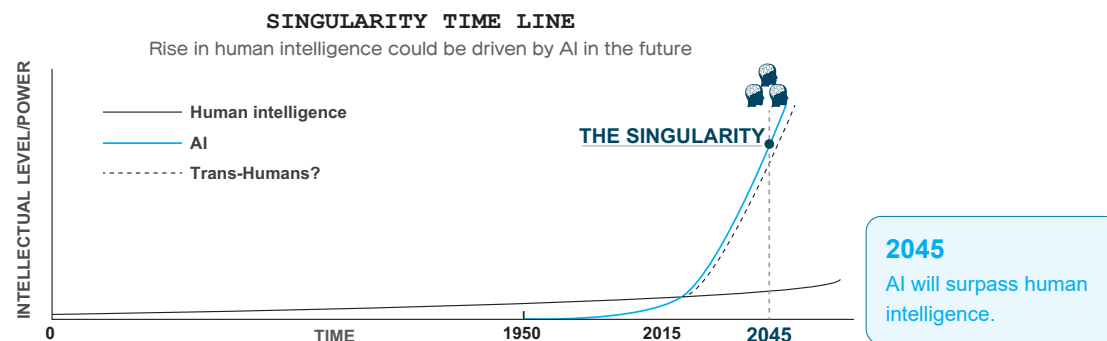
The singularity in AI refers to the technological singularity, which means a point in the future when AI **surpasses** human intelligence. The singularity is expected to come around 2045. 越える

Although human beings have developed AI, it may evolve by itself in the future. If AI continues to develop rapidly, it may be able to **strengthen itself**. Many scientists expect much of human work to be replaced by AI over time. 強くなる

Even now, AI can find and identify diseases that human doctors can't see using X-ray images. AI has also been able to defeat highly skilled players of board games, such as chess and shogi. As the processing capacities of supercomputers continue to improve, so do the capabilities of AI.

Besides weak AI and strong AI, there is also super AI which represents a level of cognitive capability that surpasses human **intelligence** and ability. Although weak AI is currently available and strong AI is being developed, super AI now only exists in **the world of science fiction**. SFの世界

Some scientists believe that humans can probably create strong AI, or Artificial General Intelligence (AGI), as some researchers call it. Once that is achieved, the singularity may soon occur. So, a future in which super AI exists may be approaching much faster than we expect.



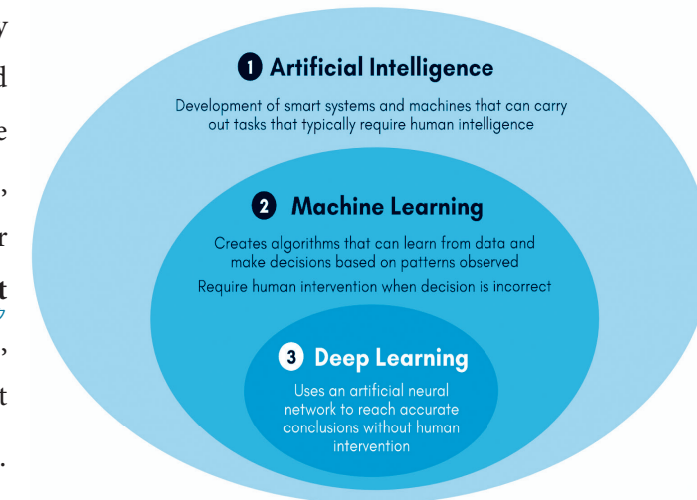
6. Understanding AI Key terms AIを考えるのに必要な用語

Practice 8 Discuss the key terms on AI: AI, machine learning, deep learning and singularity

AI

AI refers to computer systems with the **potential to adapt to** a variety of environments and situations and perform tasks that normally require human intelligence. For instance, many cars nowadays contain driver assistance systems, such as **blind-spot monitoring, cross-traffic detectors,** emergency braking, and driver-assist steering. These are basic examples of AI. 可能性 適応する 死角チェック 交差交通検出

ARTIFICIAL INTELLIGENCE VS MACHINE LEARNING VS DEEP LEARNING



www.scs.org.sg/

Machine learning

Machine learning refers to algorithms and statistical models that enable computers to perform specific tasks, without explicit instructions. The machine “decides” what to do by analyzing data, discovering patterns, and making predictions. For example, machine learning can be used in conjunction with image processing systems to enable **autonomous vehicles** to detect roadway conditions and steer appropriately. This technology is not new. As computer hardware develops and computers are able to process larger and larger volumes of data, machine learning speeds up. Also, as AI research produces more efficient learning models, the speed and efficiency of machine learning systems will continue to improve. 自律運転自動車

Deep learning

Deep learning is part of a family of machine learning methods that utilize algorithms **inspired by artificial neural networks**. These methods are intended to train AI to think and learn as humans do. While **endowing machines** with such abilities has been a challenge, it is now more possible than ever due to deep learning tools and technology. 触発された 人工神経 授ける



7. Learning outcomes What have you learned? 学んだことの整理

Self-assessment 自己評価をしよう

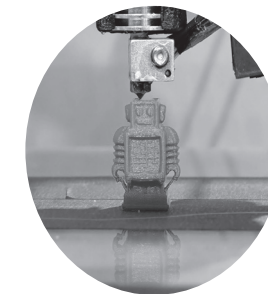
I can listen to and read what AI is .	0---30---50---70---100%
I can speak and write about how AI is used in our daily life .	0---30---50---70---100%
I can understand the ideas and problems about AI .	0---30---50---70---100%

Practice 9 A summary of learning: write a summary of what you have learned in this unit.

Key terms
Key sentences
Key facts
Your understanding
Your thoughts

Unit 2

3D printing: technology that makes our life more comfortable



3Dプリンタ:生活を快適にしてくれる技術

1. CLIL attainment target この課の学習目標を確認しよう

- | | |
|---|----------|
| 1. I can listen to and read what 3D printing is . | 聞く・読む技能 |
| 2. I can speak and write about how 3D printing works . | 話す・書く技能 |
| 3. I can understand the ideas and problems about 3D printing . | 関連の内容の理解 |

2. Introduction What is 3D printing? 3D printingとは何か?

Practice 1 Listen and check your understanding 聞き取ってみよう  07

- Which is necessary to make something with a 3D printer?
 - plastic
 - a model
 - design data
- What did the **vet** make for an injured dog? 獣医
 - a real bone
 - a 3D printed bone
 - injured bone

Practice 2 Read and check your understanding 情報を理解しよう  08

3D printing is a process of creating **three-dimensional** objects from computer-aided design (CAD) models by **layering** materials, such as **polymer filament** or **metal powder**, until objects are made. The process requires the use of a 3D printer that builds objects based upon data contained in the CAD models. Due to its flexibility and low cost, 3D printing is used in various fields, such as **manufacturing**, **architecture**, and **medicine**, to build models and **prototypes**. Despite its many advantages, some people are worried about the potential for this powerful technology to be misused.



Practice 3 Talk in pairs 内容を確認して、英語でおしゃべりしよう

Are you interested in 3D printing? Have you seen 3D printed things before?

- e.g. A: Do you want to use 3D printers?
 B: Yes, I'd love to. It's very fun to make what I want to use.
 A: Sounds nice, but I'm afraid about the cost