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Cambridge University Press 978-1-107-60630-2 – Thinking Skills John Butterworth and Geoff Thwaites Excerpt <u>More information</u>

# Unit 1 Thinking and reasoning

# **1.1** Thinking as a skill

This book is about thinking. But it is not about any thinking. It is about those kinds of thinking that take conscious effort, and which can be done well or badly. Most of our thinking takes little or no conscious effort. We just do it. You could almost say that we think without thinking! If I am asked whether I would like coffee or tea, I don't have to exercise skill to reply appropriately. Similarly if I am asked a factual question, and I know the answer, it takes no skill to give it. Expressing a preference or stating a fact are not in themselves thinking skills. There are language and communication skills involved, of course, and these are very considerable skills in their own right. But they are contributory skills to the activities which we are calling 'thinking'.

This distinction is often made by assigning some skills a 'higher order' than others. Much work has been done by psychologists, educationalists, philosophers and others to classify and even *rank* different kinds of thinking. Most would agree that activities such as analysis, evaluation, problem solving and decision making present a higher order of challenge than simply knowing or recalling or understanding facts. What distinguishes higher orders of thinking is that they apply knowledge, and adapt it to different purposes. They require initiative and independence on the part of the thinker. It is skills of this order that form the content of this book.

Skills are acquired, improved, and judged by performance. In judging any skill, there are two key criteria: (1) the *expertise* with which a task is carried out; (2) the *difficulty* of the task. We are very familiar with this in the case of physical skills. There are basic skills like walking and running and jumping; and there are advanced skills like gymnastics or woodwork or piano playing. It doesn't make much sense to talk about jumping 'well' unless you mean jumping a significant distance, or clearing a high bar, or somersaulting in mid-air and landing on your feet. There has to be a degree of *challenge* in the task. But even when the challenge is met, there is still more to be said about the quality of the performance. One gymnast may look clumsy and untidy, another perfectly controlled and balanced. Both have performed the somersault, but one has done it *better* than the other: with more economy of effort, and more skilfully.

The first of these two criteria also applies to thinking. Once we have learned to count and add, tell the time, read and understand a text, recognise shapes, and so on, we do these things without further thought, and we don't really regard them as *skilled*. You don't have to think 'hard' unless there is a hard problem to solve, a decision to make, or a difficult concept to understand. So, as with physical performance, we judge thinking partly by the degree of challenge posed by the task. If a student can solve a difficult problem, within a set time, that is usually judged as a sign of greater skill than solving an easier one.

However, when it comes to assessing the *quality* of someone's thinking, matters are more complicated. Mental performance is largely hidden inside a person's head, unlike physical performance which is very visible. If two students give the same right answer to a question, there is no telling from the answer alone how it was reached. One of the two may simply have known the answer, or have learned a mechanical way to obtain it – or

> even just guessed it. The other may have worked it out independently, by reasoning and persistence and imagination. Although the difference may not show from the answer given, the second student scores over the first in the long term, because he or she has the ability to adapt to different challenges. The first is limited to what he or she knew and could recall, or simply guessed correctly.

#### Reasoning

Reasoning is the ability most closely associated with human advancement. It is often cited as the faculty which marks the difference between humans and other animals. The famous apes studied by the psychologist Wolfgang Köhler learned ways to overcome problems, such as using a stick to get at food that was beyond their reach; but they discovered the solution by trial and error, and then remembered it for the next time. This is evidence of animal intelligence, and certainly of skill; but it is not evidence that apes can 'reason'. As far as we can tell, no animal ever draws conclusions on the basis of observable facts. None of Köhler's apes thought anything like, 'That banana is further from the bars than the length of my arm. Therefore I need to find a stick'; or 'If this stick is too short, I will need a longer one.'

Reasoning is the process by which we advance from what we know already to new knowledge and understanding. Being rational is recognising that from some facts or beliefs others follow, and using that understanding to make decisions or form judgements with confidence. If there is one overriding aim of this book it is to improve students' confidence in reasoning.

# **Creative thinking**

Reasoning is not the only higher thinking skill, nor the only kind of rationality. Imaginative and creative activities are no less important in the history of human development and achievement. But that is not to suggest that there are two distinct ways of thinking: cold hard reason on one hand and free-ranging creativity on the other. In fact, there is so much overlap and interdependence between the two that it is very difficult to say where one begins and the other ends. Clearly there are times when a seemingly insoluble problem has been cracked by an imaginative leap rather than a methodical process. Some of the greatest advances in science have been the result of creative thinking that appeared to conflict with reason when first put forward. Yet it is just as clear that many apparent flashes of genius, which seem to come 'out of the blue', actually come on the back of a lot of careful and methodical work. Likewise, new and creative ideas have to be understood and explained to be of any practical value. Reasoning is required both to enable and to apply creative thinking, just as creative thinking is needed to give a spark to reasoning.

# Reflection

Another quality that is evidently exclusive to human thinking is reflection. Reflecting means giving deep or serious or concentrated thought to something, beyond the immediate response to stimuli. When we are engaged in reflection we don't just make up our minds on impulse, but carefully consider alternatives, think about consequences, weigh up available evidence, draw conclusions, test hypotheses and so on. Critical thinking, problem solving and decision making are all forms of reflective thinking.

Moreover, the reflective thinker does not focus only on the problem to be solved, the decision to be made, or the argument to be won, but also on the reasoning processes that go into those activities. Reflecting on the way we think – or *thinking about thinking* – helps us to evaluate how effective our thinking is, what its strengths are, where it sometimes goes wrong and, most importantly, how it can be improved.

# Using this book

Throughout the book there are activities and discussion topics to prompt and encourage reflection on thinking and reasoning themselves. At regular intervals in the chapters you will find 'Activity' panels. You can use these as opportunities to close the book, or cover up the rest of the page, and think or talk - or both - about the question or task. Each activity is followed by a commentary offering an appropriate answer, or some guidance on the task, before returning to the chapter. By comparing the discussion or solution in the commentary with your own reflections and responses, you can judge whether to go back and look at a section again, or whether to move on to the next one.

Although it is not essential to do all of these activities, you are strongly urged to give some time to them, as they will help greatly with your understanding of the concepts and procedures that make up the Thinking Skills syllabus. The tasks also act as opportunities for self-assessment, both of your own personal responses, and of those of your colleagues if you are working in groups. Small-group discussion of the tasks is particularly valuable because it gives you insight into other ways to think and reason besides your own. You have the opportunity to compare your responses with those of others, as well as with the responses suggested in the commentary. The activities and commentaries are like a dialogue between you and the authors of the book.

The book can be used either for a school or college course in thinking skills, or by the student for individual study. It is divided into seven units with varying numbers of chapters within them. Although it is not a straight-line progression, there is an overall advance from basic skills to applied skills and to higher levels of challenge.

# **Preparing for examinations**

The backbone of this book is the Cambridge syllabus for A and AS Level Thinking Skills. All of the assessment objectives for that examination are covered, though not necessarily in the same order as they appear in the specification. The book does not follow the syllabus step by step or confine itself to just one examination. If it did it would not help you either to think more effectively or to do well in your exam. Critical thinking and problem solving are very broad skills, not bodies of knowledge to be learned and repeated. A competent thinker is one who is able to deal with the unexpected as well as the expected. This book therefore takes you well beyond the content of one particular exam and equips you with a deeper understanding of the processes involved, as well as a flexible, adaptive approach to the tasks you are set.

Because thinking skills are general and transferable, the topics and concepts dealt with in the coming units will also prepare you for many other awards that involve critical thinking and/or problem solving. The table on pages 342–43 shows a range of public examinations and admissions tests whose content is covered by some or all of the chapters. These include A Level Critical Thinking (OCR and AQA); the BioMedical Admissions Test (BMAT); Cambridge Thinking Skills Assessment (TSA); Singapore H2 Knowledge and Inquiry; and Theory of Knowledge in the International Baccalaureate (IB).

# **Other subjects**

Finally, the value of developing your thinking skills extends far beyond passing exams called 'Thinking Skills'! It has been shown, unsurprisingly, that confidence and aptitude in critical thinking and problem solving will assist students to achieve higher grades across all the subjects that they study. Accordingly you will find critical thinking, problem solving and presenting well-reasoned argument among the learning and assessment objectives of just about every senior-school or university course, whether in the sciences or the arts and humanities.

> Beyond that, too, these are sought-after qualities in a great many professions and occupations. Hardly surprisingly, employers want staff who can think for themselves, solve problems, make decisions and construct arguments.

#### What to expect

To give a taste of the structure and style of the book, this chapter ends with an activity similar to those which appear at regular intervals in all of the coming units. You can think of it as a trial run. The task is to solve a puzzle entitled 'The Jailhouse Key'. It is a simple puzzle, but it introduces some of the reasoning skills you will encounter in future chapters, giving a foretaste of all of three disciplines: problem solving, critical thinking and decision making.

# Activity

Two prisoners are held in a dungeon. One night a mysterious visitor appears in their cell and offers them a chance to escape. It is only a *chance* because they must first reason to a decision which will determine whether or not they actually do go free.

Their cell is at the bottom of a long flight of steps. At the top is the outer door. Three envelopes, marked X, Y and Z, are placed on the table in the prisoners' cell. One of them, they are told, contains the key to the outer door, but they may take only *one* envelope when they attempt to leave the cell. If they choose the wrong one, they will stay locked up forever, and the chance will not come again. It is an all-or-nothing decision.

There are six clues, A to F, to help them – or puzzle them, depending on how you look at it. Two are printed on each envelope. There is also a general instruction, on a separate card, which stipulates: No more than one of the statements on each envelope is *false*.

On envelope X it says:

- A The jailhouse key is solid brass.
- B The jailhouse key is not in this envelope.

On envelope Y it says:

- C The jailhouse key is not in this envelope either.
- D The jailhouse key is in envelope Z.

On envelope Z it says:

- E The jailhouse key is solid silver.
- F The jailhouse key is not in envelope X.

The prisoners may look inside the envelopes if they wish, before deciding. They have five minutes to make up their minds.

Decide which envelope the prisoners should choose in order to escape from the cell.

The best way to do this activity is to discuss it with a partner, just as the two prisoners would do in the story. As well as deciding which envelope to choose, answer this further question:

Why is the envelope you have chosen the *right* one; and why can it not be either of the others?

#### Commentary

Throughout this book you will be given questions to answer, problems to solve, ideas to think about or discuss, followed, as we have said, by commentaries. The commentaries will vary: some will provide the correct answer, if there is one. Some will suggest various possible answers, or different directions you could have taken in your thinking. The purpose of the activities and commentaries is to allow you to assess your own progress and to give you useful advice for tackling future tasks.

> Sometimes you may question or disagree with the commentary, especially later on when you have gained experience. On other occasions you will see from the commentary where you went wrong, or missed an important point, or reasoned ineffectively. Don't be disheartened if you do find you have taken the wrong tack. It is part of the learning process. Very often we learn more from making mistakes than we do from easy successes.

> In the present example there is only one answer to the question: the key is in envelope Z. The clues, although they seem confusing and contradictory, do give you all the information you need to make the correct decision. Nonetheless, there are any number of different ways to get to the solution, and you may have found a quicker, clearer or more satisfying procedure than the one you are about to see. You may even have taken one look at the puzzle and 'seen' the solution straight away. Occasionally this happens. However, you still have to explain and/or justify your decision. That is the *reflective* part of the task.

#### **Procedures and strategies**

Procedures and strategies can help with puzzles and problems. These may be quite obvious; or you may find it hard even to know where to begin. One useful opening move is to look at the information and identify the parts that seem most relevant. At the same time you can write down other facts which emerge from them. Selecting *and* interpreting information in this way are two basic critical thinking and problem solving skills.

Start with the general claim, on the card, that:

[1] No more than one of the statements on each envelope is *false*.

This also tells you that:

[1a] At least one of the statements on each envelope must be *true*.

It also tells you that:

[1b] The statements on any one envelope cannot both be false.

Although [1a] says exactly the same as the card, it states it in a positive way rather than a negative one. Negative statements can be confusing to work with. A positive statement may express the information more practically. [1b] also says the same as the card, and although it is negative it restates it in a plainer way. Just rewording statements in this kind of way draws useful information from them, and helps you to organise your thoughts.

Now let's look at the envelopes and ask what more we can learn from the clues on them. Here are some suggestions:

- [2] Statements B and F are both true or both false (because they say the same thing).
- [3] A and E cannot both be true. (You only have to look at them to see why.)

Taking these two points together, we can apply a useful technique known as 'suppositional reasoning'. Don't be alarmed by the name. You do this all the time. It just means asking questions that begin: 'What if . . .?' For example: 'What if B and F were both false?' Well, it would mean A and E would both have to be true, because (as we know from [1a]) at least one statement on each envelope has to be true. *But*, as we know from [3], A and E cannot both be true (because no key can be solid silver *and* solid brass).

Therefore:

[4] B and F have to be true: the key is *not* in envelope X: it is in either Y or Z.

This is a breakthrough. Now all the clues we need are on envelope Y. Using suppositional reasoning again we ask: What if the key were in Y? Well, then C and D would both be false. But we know (from [1b]) that they can't both be false. Therefore the key must be in envelope Z.

#### Thinking about thinking

You may have approached the puzzle in a completely different way. For instance, you may not have started with the clues on X and Z, but gone for eliminating Y first. This is perfectly possible and perfectly sensible. If the key were in Y, both the clues on Y would be false. So it could not be there and must be in X or Z. Then you could eliminate X, as in the solution above.

You may not have used the 'What if . . .?' strategy at all. (Or you may have used it but without calling it that or thinking of it that way.) Different people have different ways of doing things and reasoning is no exception. The method used above is not the only way to get to the solution, but it is a powerful strategy, and it can be adapted to a wide variety of situations. The method, in general terms, is this: Take a statement – we'll call it S – and ask yourself: 'If S is true, what else would have to be true too?' If the second statement can't be true, then nor can S. You can do the same thing asking: 'What if S is *false*?' If you find that that would lead to something that can't possibly be true, then you know that S can't be false but must be *true*. (If you do Sudoku puzzles you will be very familiar with this way of thinking, although you may not have a name for it.)

Whether you proceeded this way or not, study the solution carefully and remember how it works. Think of it as an addition to your logical toolbox. The more procedures and strategies that you have in the box, the better your chances of solving future problems or puzzles.

#### Summary

- When we talk of thinking as a skill we are referring to higher-order activities, such as analysing, evaluating and explaining; and to challenges such as problem solving and evaluating complex arguments.
- Three broad categories of higher-order thinking are reasoning, creativity and reflection. They all overlap.
- Reflection includes 'thinking about thinking'. In many ways the content of this book is thinking about thinking: thinking more confidently, more skilfully and more independently.

6 Unit 1 Thinking and reasoning

# **1.2 An introduction to critical thinking**

What makes some thinking *critical*, others *uncritical*?

'Critical', 'criticism' and 'critic' all originate from the ancient Greek word *kritikos*, meaning able to judge, discern or decide. In modern English, a 'critic' is someone whose job it is to make evaluative judgements, for example about films, books, music or food. Being 'critical' in this sense does not merely mean finding fault or expressing dislike, although that is another meaning of the word. It means giving a fair and unbiased opinion of something. Being critical and *thinking* critically are not the same thing.

If critical thinking did just mean judging, wouldn't that mean that anyone could do it simply by giving an opinion? It takes no special training or practice to pass a judgement. If I watch a film and think that it is boring, even though it has had good reviews, no one can really say that my judgement is wrong and the professional critics are right. Someone can disagree with me, but that is just another judgement, no better or worse, you might say, than mine. In a limited sense, this is true. But a serious critical judgement is more than just a statement of preference or taste. A critical judgement must have some basis, which usually requires a measure of knowledge or expertise on the part of the person making the judgement. Just saying 'I like it' or 'I don't like it' is not enough. There have to be some grounds for a judgement before we can call it critical.

# Critical Thinking (and critical thinking)

We should also be aware of the difference between 'critical thinking', as a general descriptive term, and Critical Thinking (with a large C and T), which is the name of an academic discipline with a broadly defined syllabus. This book addresses both. In Units 2, 4 and 7 it covers the Critical Thinking (CT) component of the Cambridge and other syllabuses. But it goes well beyond the confines of exam preparation. In fact, having mentioned the distinction, we can largely ignore it. To have maximum value, thinking skills have to be transferable from one task or context to others. The aim of this book is to instil in students a critical approach to reading, listening and reasoning generally; and to provide the conceptual tools and skills that enable them to respond critically to a wide range of texts. The CT syllabus gives the book its structure but not its whole purpose.

The objects of critical focus are referred to generically as 'texts'. The word is used in its broadest sense. In real life a 'text' can be spoken or written or visual: a television programme, for example, or Tweet or blog; or just a conversation. In a book, of course, the texts are restricted to objects which can be placed on a page, so that they are often referred to instead as *documents*. Most of the documents that are used in the coming chapters are in the form of printed texts. But some are graphical or numerical; or a mixture of these. Two other generic terms that are used

7

> are 'author' and 'audience'. The author of a text is the writer, artist or speaker who has produced it. The audience is the receiver: reader, watcher or listener.

Some CT textbooks give the impression that critical thinking is directed only at arguments. This can be quite misleading if it is taken too literally. Arguments are of particular interest in CT, but by no means exclusively so. Information, items of evidence, statements and assertions, explanations, dialogues, statistics, news stories, advertisements . . . all of these and more may require critical responses. What these various expressions have in common is that they all make *claims*: that is, utterances that are meant to be true. Since some claims are in fact untrue, they need to be assessed critically if we, the audience, are to avoid being misled. We cannot just accept the truth of a claim passively. Arguments are especially interesting because their primary purpose is to persuade or influence people in favour of some claim. The critical question therefore becomes whether the argument succeeds or fails: whether we should allow ourselves to be persuaded by it, or not.

# **Activities**

The core *activities* of CT can be summarised under the following three headings:

- analysis
- evaluation
- further argument.

These recur throughout the book with different texts and different levels of challenge. As they are fully discussed in the coming chapters there is no need to flesh them out in detail here, but they do need a brief introduction:

*Analysis* means identifying the key parts of a text and reconstructing it in a way that fully and fairly captures its meaning. This is particularly relevant to arguments, especially complex ones.

*Evaluation* means judging how successful a text is: for example, how well an argument

supports its conclusion; or how strong some piece of evidence is for a claim it is supposed to support.

*Further argument* is self-explanatory. It is the student's opportunity to give his or her own response to the text in question, by presenting a reasoned case for or against the claims it makes.

(In most CT examinations, including Cambridge, these three tasks are set and assessed in roughly equal measure. They are referred to as the three 'assessment objectives'.)

# Attitude

As well as being an exercise of skill and method, critical thinking also relates to an attitude, or set of attitudes: a *way* of thinking and responding. Here is a fragment from a document. It is just a headline, no more. It belongs to an article exploring the history of aviation in the magazine section of a newspaper. It challenges the familiar story of the first manned, powered flight in a heavierthan-air machine, by Wilbur and Orville Wright in 1903. The headline reads:

WRIGHT BROS NOT FIRST TO FLY

Suppose you have just glanced at the headline, but not yet read the article. What would your immediate reaction be? Would you believe it on the grounds that the newspaper would not print it if it wasn't true? Would you disbelieve it because for so long it has been accepted as a historical fact that Wilbur and Orville Wright were the first? Might you even take the cynical view that journalists make claims like this, true or not, just to sell papers? (After all, it would hardly make 'news', over a century later, to announce that the Wright brothers *were* the first to fly!)

Such reactions are common enough among readers. What they are not is *critical*. They are either passively accepting, or too quickly dismissive. All suggest a closed mind to the question behind the headline.

Critical thinking, by contrast, should always be:

- fair and open-minded
- active and informed
- sceptical
- independent.

Most of these speak for themselves. Without an open mind we cannot judge fairly and objectively whether some statement or story is true or not. It is hard sometimes to set aside or discard an accepted or long-held belief; but we must be *willing* to do it. Nor can we judge any claim critically if we know nothing about it. We have to be ready to take an active interest in the subject matter, and be prepared to investigate and enquire. Hasty, uninformed judgements are never critical. At the very least we would need to read the article before an informed judgement is possible.

Some degree of scepticism is also needed: a willingness to question or to entertain doubt. Scepticism is not the same as cynicism. For example, it doesn't mean doubting everything that journalists write as a matter of course because you think that they are driven only by the wish to grab the reader's interest, with no regard for fact. Critical appraisal requires each claim or argument to be considered on its merits, not on blanket prejudgements of their authors – however justified those may sometimes seem.

Lastly, critical thinking requires independence. It is fine to listen to others, to respect their beliefs and opinions, to learn from teachers, to get information from books and/or from online sources. But in order to think critically you must also be prepared to take some initiative: to ask your own questions and reach your own conclusions. We get very used to being told or persuaded what to think, so that being faced with choices or decisions can be uncomfortable. The methodology of critical thinking can give you greater confidence in your own judgements, and more skill at defending them. But *exercising*  the judgement – using it to form your own views – is ultimately up to you.

You cannot evaluate a bare assertion without considering the reasons its author has for making it. So the whole article is presented on the next page. Read the document and then have a go at the following question, a typical critical thinking task.

# Activity

How strongly does the information in the article support the headline claim that the Wright brothers were *not* the first to fly?

You can answer this individually, or in a discussion group of two or more. Use your own words. It is an introductory activity, so you are not expected to use any special terms or methods.

#### Commentary

This is a typical critical thinking question, and one you will be asked in one form or another many times on different topics. This commentary will give you an idea, in quite basic terms, of the kind of critical responses you should be making.

Firstly, with any document, you need to be clear what it is saying, and what it is doing. We know from this article's style that it is journalistic. But perhaps the most important point to make about it is that it is an *argument*. It is an attempt to persuade the reader that one of the most widely accepted stories of the 20th century is fundamentally wrong: the Wright brothers were not the first to fly a powered aeroplane. That claim is, as we have seen, made in the headline. It is echoed, though a bit more cautiously, in the caption beside the first photograph: 'Or did they (make history)?' The article then goes on to give, and briefly develop, four reasons to support the claim.

Two obvious questions need answering: (a) whether the claims in the article are

# WRIGHT BROS NOT FIRST TO FLY



*Wilbur and Orville Wright make history at Kitty Hawk, USA, December 1903. Or did they?* 

Many aviation experts and historians now believe that German-born Gustave Whitehead – seen here with his aeroplane 'No. 21' – beat the Wright brothers into the sky by as much as two or even three years.

In a 1935 article in the magazine *Popular Aviation*, and a book published two years later, author and historian Stella Randolf tells of a steam-powered flight made by Whitehead in 1899, in Pittsburg, and of signed affidavits from 20 witnesses. One was Louis Daravich, stating that he was present and accompanied Whitehead on his flight. Randolf tells of two more flights, in 1901 in a plane that Whitehead named 'No. 21', and another in the following year in 'No. 22'.

A headline from the *New York Herald,* dated August 19, 1901 read: 'Gustave Whitehead travels half a mile in flying machine . . .', and quoted a witness who affirmed: 'The machine worked perfectly, and the operator had no problem handling it.'

Whitehead was a poor German immigrant to the United States, whose voice was easy to drown out in the debates that followed. The Wrights, by comparison, had influential friends and supporters. The prestigious Smithsonian Institute for Science, in return for ownership of the Flyer, agreed not to publish or exhibit anything referring to flights before 1903. The question we should be asking is: Why?

The jury is not so much *out*. The jury has gone home, and the case is closed. History suggests it is time to reopen it.

Jacey Dare



Gustave Whitehead, pictured with his aeroplane 'No. 21', and his daughter and assistants

**10 Unit 1** Thinking and reasoning