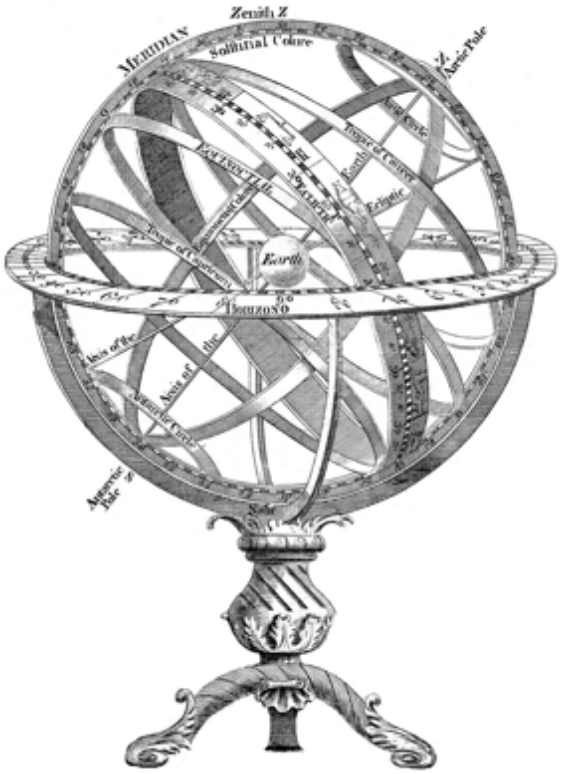
Exploring Complexity



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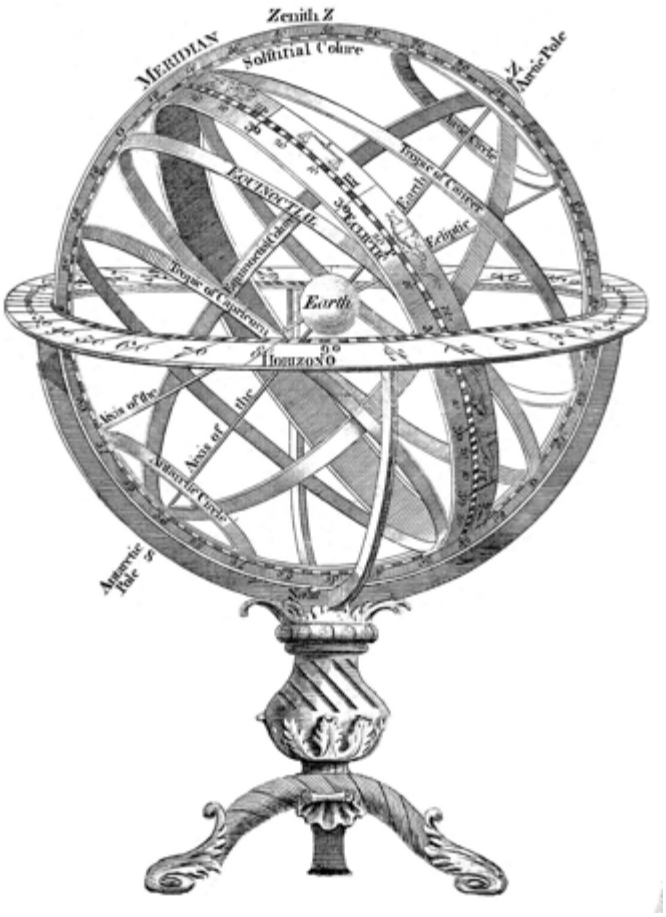
Introduction



THE PURPOSE OF THESE MATERIALS

The world is full of complexity. Every day we use complex objects such as computers, cell phones, and automobiles. Over the course of a day we depend on numerous complex systems, from indoor plumbing to school schedules to the myriad internal systems that comprise our own bodies. We study complex topics like democracy and chemistry and private property. We engage with complex global issues like immigration and climate change and animal rights. Even things that seem simple of the surface, like a bottle of water or a pair of shoes or a simple math problem, reveal complexity when we start to wonder about what they're made of or where they come from or how they work.

These materials offer some tools and strategies for exploring complexity. Their purpose is to help students enter and investigate the complexity of ideas, objects and systems from a variety of vantage points. For example, consider the issue of how to address global climate change. Exploring its complexity involves identifying multiple and often competing perspectives, looking closely at interacting factors, recognizing conflicting values and forces, appreciating issues of power, truth, and leadership. The outcome of such an inquiry is a deeper understanding of the anatomy of the issue -- an understanding of its parts, its dimensions, its tensions, its uncertainties. Such an exploration *constitutes* deeper understanding, whether or not it leads to an untangling of the issue, or even a resolution about one's own stand on it. The same holds for other kinds of complex things, from physical objects to natural and human-made systems, to big ideas. All of these things have a background, a context, a history. They are made up of interacting parts, and can be viewed from multiple and sometimes competing perspectives. Learning to uncover and explore their complexity is a way of coming to know them better.

Many educational approaches aim to steer students *away* from complexity, and instead try to present topics in a simplified form. So why should students learn to explore complexity rather than avoid it? Because the process of uncovering, navigating and probing complexity is a form of inquiry that leads to deep understanding. This is true even when – or perhaps especially when—the inquiry doesn't dissolve complexity or lead to a single right answer. Also, exploring complexity tends to be engaging for students: Once students understand that they are not required to solve complexity but rather to explore its twists and turns, students are free to follow their curiosity. Moreover, exploring complexity develops general thinking skills and dispositions that are important to learning more broadly, such as close observation, systems thinking, perspective taking, empathy, and a tolerance for uncertainty.

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HOW TO USE THESE MATERIALS

In this set of materials you'll find several different *thinking routines* that help students explore complexity. A thinking routine is a short, stepwise procedure that helps students think deeply about something. Thinking routines are designed to be simple to use and to teach themselves as they unfold. Neither you nor your students need prior experience with thinking routines in order to use them successfully. The concept of thinking routines was originally developed at Project Zero as part of the Visible Thinking approach. You can learn more about Visible Thinking and related Project Zero resources in the Further Resources section at the end of these materials.

The materials also contain some resources for choosing complex topics to explore with your students, and for guiding and assessing students' thinking.

There are two different ways to begin using these materials. Feel free to use whichever option appeals to you:

1. Introduce the theme of complexity to students by having a class discussion that helps students learn how to identify and uncover different kinds of complexity. To help prepare for this discussion, use the diagram, *Kinds of Complex Things,* to help you choose an introductory topic. Then use the guidelines and diagram in the *Ways Things can be Complex* section to help structure a discussion by asking students to look for complex things in the various categories it mentions

- or -

2. Pick any of the thinking routines and just dive in. Simply read it over, select an object or topic to use it with, and then try it with students. If you like, use the *Finding Topi*cs resource sheet to help identify a topic.

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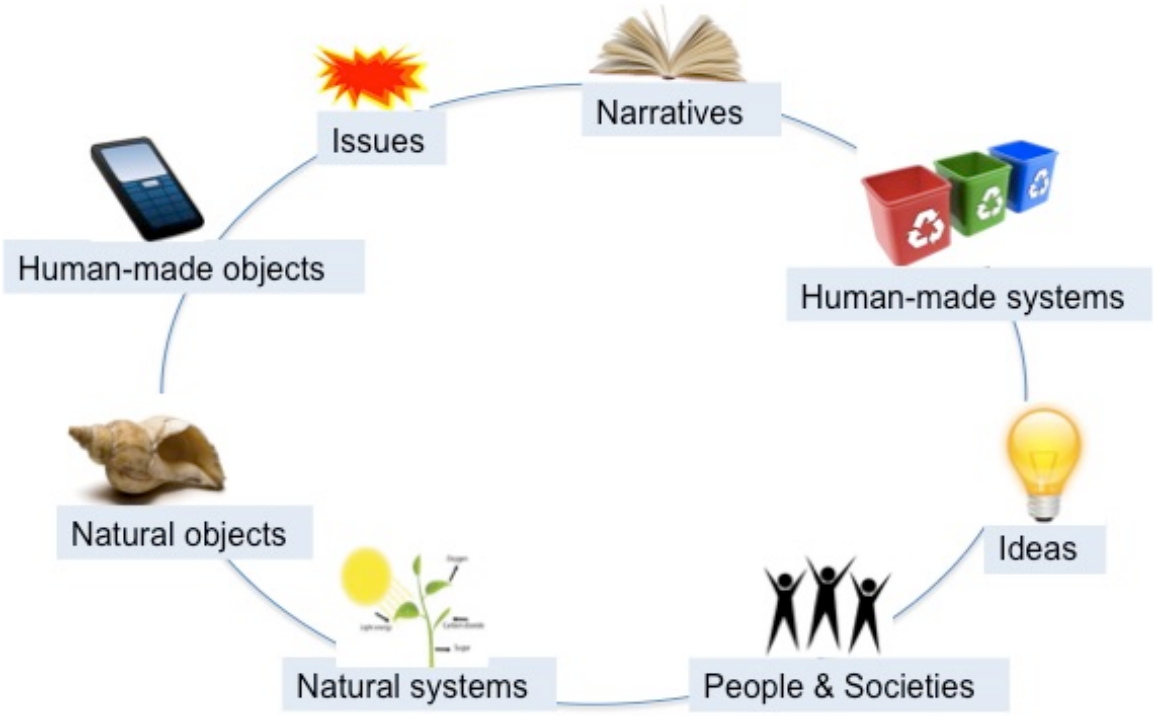
KINDS OF COMPLEX THINGS

There are all kinds of complex things in the world. This diagram offers a starting place to help you find complex topics. The diagram is just a loose guide: often topics fit into more than one category, and sometimes a topic that starts out in one category spreads to other categories, once you begin to uncover its complexity.



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WAYS THINGS CAN BE COMPLEX

Things can be complex in many ways. In fact, that is often what makes them complex. The diagram on the next page identifies several different types of complexity. Each type is accompanied by a few questions that help point students toward the kind of complexity in question. Not all the categories apply equally well to a single topic. For example, a bicycle can be viewed as a complex object: it has many interacting parts, it may change over time, and so on. But it isn't really useful to consider the complexity of truth related to a bicycle. A bicycle just *is*. That is unless you are examining the environmental friendliness of bicycle manufacturing, in which case truth may well be an issue.

The diagram can be useful in several ways

- **Use it to plan an introductory lesson on complexity**. Choose a topic or object. Tell or show it to students, and show them the *Ways Things can be Complex* chart. Ask students to consider each of the categories and explore which kinds of complexity can be uncovered in the topic.
- Use the chart to expand your own ideas about complexity.
- Use it to help you think about which types of complexity you particularly want to emphasize in relation to particular topics.
- Use the chart to identify and gauge the quality of students' thinking: Which kinds of complexity are they exploring? How deeply are they exploring them?

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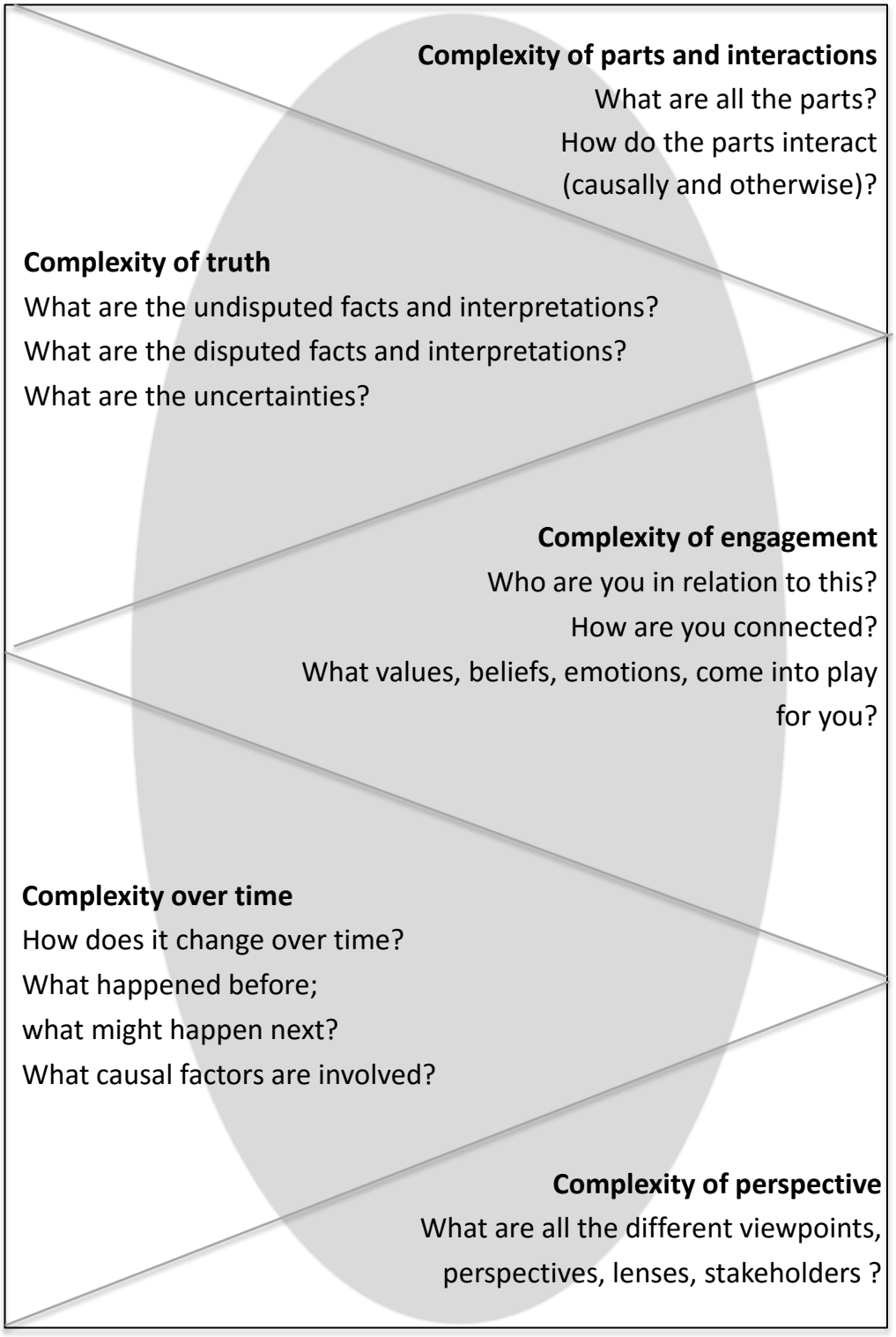
Ways Things can be Complex



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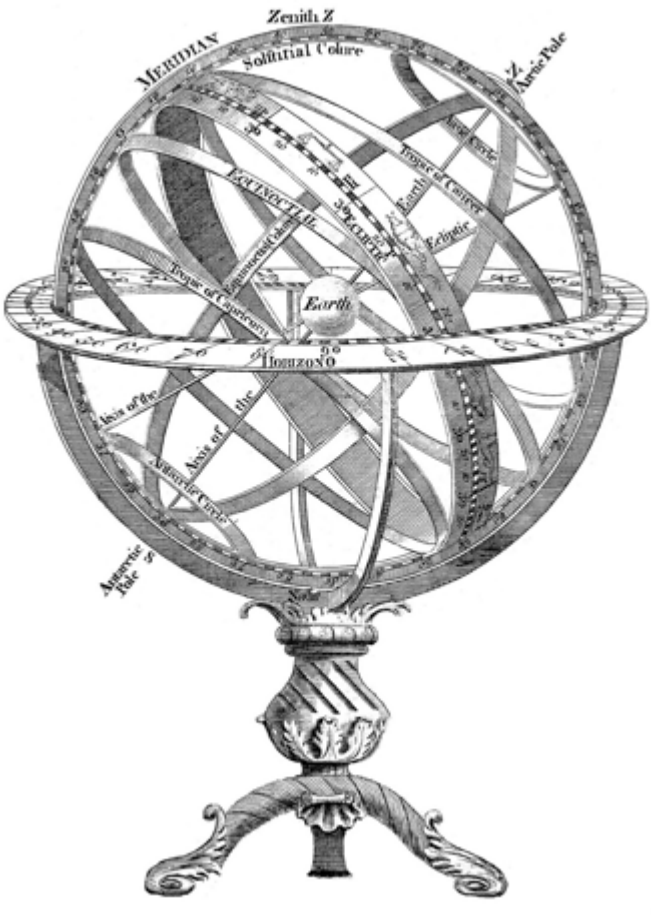
Complexity Thinking Routines



PARTS, PEOPLE, INTERACTIONS

EXPLORING SYSTEMS

Identify a system and ask:

What are the **parts** of the system?

Who are the **people** connected to the system?

How do the people in the system **interact** with each other and with the parts of the system?

How does a change in one element of the system **affect** the various parts and people connected to the system?

PARTS, PEOPLE, INTERACTIONS: Q & A

What Kind of Thinking Does This Routine Encourage? This routine helps students slow down and look closely at systems, with special emphasis on the various ways people engage with or are implicated in systems. Like the other routines that begin with identifying parts, the routine encourages students to make careful observations. It also encourages them to identify various kinds of causal interactions, and to consider the numerous ways that people affect and are effected by systems.

When and How Can This Routine Be Used? This thinking routine can be used to explore the human side of almost any kind of system. There are systems at work in virtually every aspect of our lives--environmental, governance, financial, workflow, logistical, distribution, mechanical, medicine, etc. The routine can be used on any kind of system, large or small, in which people figure in some way. Here are some tips for putting this thinking routine into practice:

- Before introducing the routine, it can be helpful to discuss the concept of systems with students. A good way to begin is to ask students what they think the word 'system' means, and encourage them to brainstorm several ideas and examples. A common definition of a system is: A group of interacting or interrelated elements that form a complex whole. While this definition is accurate, it isn't very illuminating unless it is accompanied by concrete examples, e.g., subway systems, town recycling systems, the lunch line system at school, etc. Since systems are everywhere, it can also be helpful to discuss what *isn't* a system. For example, a random heap of stuff, such as you might find in the back of a closet, isn't typically a system.
- A good way to identify a system on which to use this routine is to begin with a concrete object or activity and then situate it within a broader system. For example, a postage stamp can be situated within a broader postal system and a bicycle helmet can be situated within a broader transportation system. A walk to school can be situated in a broader system of transportation. Brushing one's teeth can be situated in a broader system of health maintenance.
- Systems are made up of subsystems, and are themselves parts of broader systems. In order to avoid going down the rabbit hole of *everything is connected to everything*, it may be helpful to encourage students to define the boundaries of their system. For example, if you are exploring the system of making an apple pie, you might limit it one particular pie; if you are exploring a recycling system, you might limit it to a geographical area.

How can students' thinking be made visible while using this routine? Working in groups, it is helpful for students to begin by making a list of all of the parts and people involved in a system, and then to map out their system on chart paper to make the interactions between all of the parts and people in their system visible.

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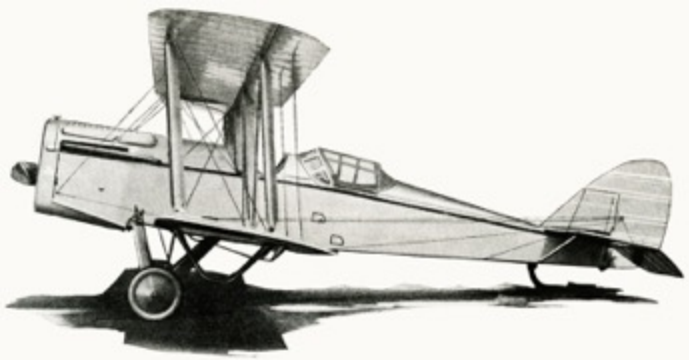
PARTS, PERSPECTIVES & ME

A ROUTINE FOR EXPLORING THE COMPLEXITY OF OBJECTS AND SYSTEMS



Choose an object or system and ask:

What are its **parts**?

What are its various pieces or components?

What **perspectives** can you look at it from?

Different users, makers; different physical perspectives.

How are ***you*** involved?

What connections do you have? What assumptions, interests or personal circumstances shape the way you see it?

PARTS, PERSPECTIVES, ME: Q & A

What kind of thinking does this routine encourage? The routine helps students explore complexity by encouraging them to look closely at the details of something, considering its various viewpoints, users, and stakeholders, and reflecting on their own connections and involvement with it.

On what topics can this routine be used? It can be used to explore virtually any object or system. It works particularly well with objects that have many parts – and can be taken apart—as well systems that have various roles and users connected to them, such as systems involved in managing or providing resources, social systems, organizational systems, transportation systems or governance systems.

Should the routine be used all at once, or step by step? The three elements of this routine can be introduced all at once, but each of the steps encourages a different kind of thinking, so it is helpful to distinguish the steps from one another, and to give each step time to unfold.

What are some tips for the 'parts' step? Give students plenty of time to look at or otherwise experience the topic in detail. If the object is physically present, students can sketch it, or make a diagram. If appropriate, they can take it apart. (Taking things apart—from doorknobs to old household appliances to toys--is a particularly powerful way to look closely at the parts of something)

What are some tips for the 'perspectives' step? Encourage students to imagine different physical viewpoints if appropriate, for example by zooming in, zooming out, or taking a bird's eye view. Encourage them to think broadly about how different people interact or are connected to the object or system: who is involved in making it, who is affected by it, who cares about it? When possible, encourage students to gather information about other perspectives, for example by interviewing people or doing research.

What are some tips for the 'How are you involved?'' step? Encourage students to consider the different ways the object or system touches their lives or the lives of people they know. Encourage them to consider any feelings, assumptions, connections, beliefs, attitudes or associations they have with it.

How can students' thinking be made visible while using this routine? As with the other routines that begin with the naming of parts, students can make their thinking visible by creating lists, sketches, and diagrams.

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PARTS, PURPOSES, COMPLEXITIES

Choose an object or system and ask:

What are its **parts**?

What are its various pieces or components?

What are its **purposes**?

What are the purposes for each of these parts?

What are its **complexities**?

How is it complicated in its parts and purposes,
the relationship between the two, or in other ways?

PARTS, PURPOSES, COMPLEXITIES: Q & A*

What kind of thinking does this routine encourage? The routine helps students slow down and make careful, detailed observations by encouraging them to look beyond the obvious features of an object or system. The routine stimulates curiosity, raises questions, and surfaces areas for further inquiry.

On what topics can this routine be used? It can be used to explore virtually any object or system. It works particularly well with things that students can directly observe or diagram. If you use the routine with an object or system from the natural world, as opposed to a human-designed object or system, you may want to substitute the word 'function' for 'purpose. This is because human-made objects and systems are made with intentional purposes in mind, whereas in the natural world, form and function co-evolve without requiring explicit intentionality.

How much background knowledge do students need in order to use this routine? If the topic is an object that is physically or visible, students may not need a lot of background knowledge. However, if students are working with a system that extends beyond what they can observe at the moment—like democracy or recycling—it may be helpful for students to have some background knowledge, or to give them an opportunity to reflect on their experiences interacting with that particular system.

Should the routine be used all at once, or step-by-step? The three elements of this routine can be introduced all at once, but it is often helpful to begin by taking extra time with the *parts* step, in order to give students plenty of time to make detailed observations. (If an object is physically present, students can be encouraged to draw its parts, as a way of looking closely.) Once students have taken time with the *parts* step, the next two steps – *purposes* and *complexities*—often flow together naturally.

How can students' thinking be made visible while using this routine? The routine provides an opportunity to make students' thinking visible through creating lists, maps, and drawings of the parts, purposes, complexities of various objects and systems. Often students discover linkages between the three steps of the routines and their diagrams can including lots of connecting lines and annotations—and even look messy at times. This is generally a good thing, as it is an indication that students are discovering the genuine messiness of complexity.

Can this routine be used with very young students? Yes, though generally for students in preK-4 you may want to lead the discussion and make one collective chart or diagram. Also, you may consider swapping out the word *complexities* for more accessible terms, such as *puzzles* or *questions*.

*This routine is one of three routines in the Exploring Complexity materials that begins with the naming of parts. Naming parts is an important way of exploring complexity because it reveals how objects and systems have numerous interacting components.

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Slow Complexity Capture

FIND
Find an object or scene that that captures your eye. In a word or phrase, say what it is.

CAPTURE
Take some time to look carefully at your item. Capture it by slowly making a drawing of it or taking pictures of it from different angles or perspectives. Don't worry about creating a 'good' or realistic drawing or picture. The goal is to use drawing or picture-taking to help you look closely and notice details. Spend at least 5-10 minutes observing through drawing, looking, and/or photographing.

EXPLAIN
After you have visually captured your item, write a paragraph (or tell a friend) about how it is complex.

WONDER
What new ideas and questions do you have about your item?

SLOW COMPLEXITY CAPTURE: Q & A

What is the purpose of this routine? The routine helps students slow down and use the medium of drawing or photography as a tool for looking closely. By taking time to make extended observations, students will begin to see the complexity inherent in the design, composition and constitution of even everyday objects and scenes. The routine mainly emphasizes the complexity of parts and interactions, but it may also help student see other kinds of complexity (see the 'Ways Things Can be Complex' page).

How can I encourage students who may not be comfortable with drawing? Emphasize that the purpose of the routine is to help students make careful observations, not to produce polished work. If students don't know where to start, offer some simple strategies or techniques. For example, create a grid of 4 or 6 squares and ask students to fill in each square with a quick sketch. Or have students make a contour drawing by drawing the outlines of something without lifting their pencil from the paper—and perhaps by looking only at the object, not at the drawing or their hand.

How can this routine be varied? Students can capture an object or item from several different perspectives (as in the picture above); they can focus in on a single aspect of something and capture it in careful detail; they can make a rough sketch of an entire scene; they can make multiple sketches of the same scene. Additionally, students can vary their work configurations. For example, they can work in pairs, or small groups in which each person creates a capture of the same item from a different angle or perspective. Then they share their captures with one another, discuss them, and together describe the way in which their item is complex.

What kind of support and feedback can I provide to students? When responding to student work, emphasize the observational qualities of students' drawing, rather than their technical qualities. Support students' explanations of complexity by using language and ideas from the 'Ways Things Can be Complex' page. Support their wonderings by appreciating the many different kinds of questions they have, and invite them to explain how observing through drawing/photographing helped them to ask new questions.

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Sticking Points
Mapping Messy Controversies

Choose a big issue and look at these four facets...

Facts
What facts do people differ on? What facts do they agree on?

Values
What values do people differ on? What values do they agree on?

Interests
What practical interests (e.g. investments, land, group loyalty) do people differ on? What practical interests do they share?

Policies
What policies (i.e. general actions to take) do people differ on? What policies do they agree on?

Follow-Up Conversations

1. How does the pattern of Facts-Values- Interests-Policies differ by different *groups*, e.g. scientists, people from different political parties, business people, workers, different nationalities, etc.?
2. How could progress be made without necessarily completely agreeing? E.g. people might try to settle some facts, find some common interests, arrive at a compromise policy. What are the opportunities in this case?

STICKING POINTS: Q & A

What kind of thinking does Sticking Points encourage? It's to help learners understand today's complicated world by digging into the big controversies so common today. Straightforward agreement is often difficult, but learners can get a grip on complicated issues through appreciating the sources of different viewpoints. Over time, students can come to some insights about controversies in general – see the next page!

How do I use this routine? Lead a class discussion. Students might get ready with small group discussions beforehand. As students talk, make their thinking visible with a concept map on the whiteboard, or have your students post Post-its. Facts-Values-Interests-Policies is a good order but use any order for your purposes. Expect to spend 20 minutes to an hour or more, depending on how deep you want the class to go.

Can I use Sticking Points on past issues as well? Absolutely! Just ask your students to try to think about a past controversy *as it was seen at the time*.

Is Sticking Points just for history and social studies? It's much more general. It can be used for controversies in science about global warming or genetically engineered organisms, big debates in the arts, etc. Anywhere groups are taking strong opposing positions!

What if my students don't know that much about the issue? You could have an initial conversation size that up, and make an assignment to investigate different viewpoints.

Controversies are about disagreement. Why does the routine also ask where people agree? Because advocates tend to foreground the disagreements, often it seems there is disagreement on everything! It's good for learners to appreciate where the agreements are, because they are a starting point for resolving, or at least reducing, the controversy.

What about investigating how different groups have different viewpoints? That's what Follow-up #1 is about. For instance, you could ask students form clusters and chart the Facts-Values-Interests-Policies profile for different groups. Or they could make a big whiteboard table: Facts-Values-Interest-Policies on top, rows for different groups.

Does the class have to agree on a resolution of a controversy? No, that would be asking too much. The main idea is to help learners understand the controversy and appreciate different sides. However, ways forward can be explored, as with Follow-up #2.

Can students learn anything of immediate personal significance about controversies? Sticking Points can apply to interpersonal conflicts and local community and school controversies.

Can students learn anything from Sticking Points about controversies in general and how they work? After using Sticking Points several times, you can lead a general discussion about how controversies work. On the following page there are some ideas the discussion might get to.

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Some General Understandings about Controversies that Discussion Might Get To

- *Complex public issues are not just intractable swamps of opinion and hype*. Under the swamp, there are systematic patterns of facts, values, interests and policies.
- *People on different sides of the controversy typically do agree on some things*. When people argue, they tend to emphasize their disagreements, so it's easy to lose sight of that!
- *For a particular individual or group, facts, values, interests, and policies tend to hang together in a mutually reinforcing pattern, an overall viewpoint*.
- *What people take as the facts is often strongly influenced by their values and their interests*. Moreover, people often are not aware of this.
- *But this doesn't mean that 'the facts' are nothing but opinion*. There usually is some evidence that can be carefully weighed, and some people are responsive to it.
- *In many politicized controversies, sides pick their facts*, leaving out facts that don't work so well for them; and often exaggerate; and sometimes misrepresent outright.
- *Sometimes the experts just don't know, but often they are closer to agreement than they seem.* The media and politicians frequently present issues as more controversial than they are to experts. Often the experts are arguing about details, not the big picture.
- *The heart of a controversy can lie in different places*. For instance, whether global warming is caused by human activity and to what extent, even though debated and entangled with matters of values and interests, in the end is a factual issue. But what we should do about it (policy) is not just a factual issue.
- *Controversial issues do often get resolved eventually*. For instance, the health effects of smoking, mainly a question of fact, was very controversial decades ago but is now resolved. Slavery, mainly a question of values, was a contentious issue for a long time. For most of human history most cultures practiced some form of slavery. But in today's world, slavery is universally recognized as bad.
- *People often perceive those on the other side of an issue as having more extreme positions than in fact they do*. There are real differences, but political processes and the big voices in the media tend to amplify opposing groups' perceptions of the degree of difference.
- *People within a group (e.g. a political party, a particular ethnic group) often differ greatly from one another on an issue, even though in trend the group comes down on one side*. We shouldn't stereotype groups by thinking that everybody believes exactly the same thing.
- *It's not so that "one opinion is just as good as another."* Some people may be much better informed and may have thought about an issue much more. They may still disagree, but their views are more fully developed.
- *It's not always the case that everyone should agree in the end*. Perhaps everyone should agree on the facts once enough research is done, but it's often reasonable to have different values and interests and to have policies that go with those values and interests.
- *There are many worthwhile goals around a messy issue besides settling the issue anytime soon.* Some of those goals include, for example: understanding the issue better, knowing what big questions to pursue, arriving at a provisional position while keeping an open mind, stepping away from misrepresentations of fact and extreme and indefensible values and interests.

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STORIES

UNCOVERING ACCOUNTS OF COMPLEX ISSUES

Consider how accounts of issues, events, people, society, etc. are presented; what has been left out, and how you might want to present the account.

What is the story that is presented?

What is the account that is told?

What is the untold story?

What is left out in the account? What other angles are missing in the account?

What is *your* story?

What is the account that you think should be the one told?

STORIES: Q & A

What kind of thinking does this routine encourage? This thinking routine invites learners to (1) explore how accounts of issues, events, people, society, etc. are presented; (2) tease apart and rethink the various angles, dimensions and scope of accounts; (3) consider what has been left out in the account; and (4) take a stand on the kind of account that they would want to hear.

Should the routine be used all at once, or step-by-step? It is advisable to use the prompts in the order they are presented, as the sequence is designed to support learners in uncovering how narratives are presented and how they could be re-thought.

- The prompt "What is the **story**?" invites learners to understand how an issue, event, people, society, etc., is presented. If the material used with the thinking routine presents more than one perspective, consider dividing the learners into groups and assigning them a specific perspective. That way, these different "stories" will flow naturally into the next prompt, where different angles and perspectives are brought into the mix.
- The prompt "What is the **untold** story?" invites learners to explore the multiple angles, perspectives and dimensions in complex issues, events, people, society, etc., as well as hypothesize the motivations for the account: whose account is this? What has been left out? What has been emphasized? What was made less significant? Who does this account advantage and disadvantage? In what way is it easy to not pay attention to? Unpack it for learners by asking them: *what might people not want us to know about the issue, event, people, society, etc.,* or *what do people not pay attention to or don't think about?*
- The prompt "What is ***your*** story?" invites learners to bring their own perspective and aspirations into the topic or issue. Unpack the prompt by asking learners: *How would you rewrite this story? What perspective would you take and why? How would the story ideally be like 'in a different world'?* While it is not intended to be an invitation for learners to relate their own experiences, the prompt is still roomy enough for learners to use their lived experiences as a basis for what they hope to see happen with the topic or issue, or why their aspiration matters.

What are some other ways to use the prompts? You may want to use additional prompts to target specific goals, such as:

- to move from a local to a global perspective - "*What is a **bigger** story that this story could be connected or related to?*"
- to think about what an individual's account could be - "*What is a **smaller** story that this story could be connected or related to?*"
- to consider how different disciplinary experts might explain or describe the issue, event, people, society, etc. - "*What is the **scientific/historical/ literary/etc.** story?*"

You may also consider framing the prompt "What is ***your*** story?" as "*What is **his/her** story? What is **our** story?*" when you want learners to explore multiple perspectives on the issue, event, people, society, etc., and begin to craft a collective account.

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Who Am I?

THE COMPLEXITY OF IDENTITY

A routine for digging deep beneath the surface and many layers to get to the core of identity.

THINK ABOUT WHO YOU ARE AND THEN ABOUT SOMEONE ELSE

Consider how you have become who you are, where you belong and what that can mean in our changing world.

Explore
Who am I?
How has my identity developed?

Connect
I am connected to my parents, their parents and my brother and sister and I'm in the basketball team. Who else and what else am I connected to?

Identify
If I wanted others to know who I am, what would identify me?
Do we have more than one identity?

Belong
Where do I think I belong?
Do I have a sense of belonging to more than one group, more than one place?

WHO AM I?: Q & A

What is the purpose of this routine? It is not unusual for people, systems, objects or ideas to be judged or given labels without others really knowing much about them. This routine encourages students to reserve judgment, take time to find out more about what they see and/or hear, and explore more deeply and broadly other people, and develop greater understanding of similarities and differences.

Identity can be a sensitive matter in some contexts.

How can I handle that? As a teacher, you make decisions all the time about what will serve your students and your context well. If in your judgment, this routine will not serve your context well, don't use it! Or maybe parts of it would serve well, or some adaptation. (This does not mean we should never take up sensitive matters in our classes; arguably we should from time to time. But it's always a judgment call.)

What other questions can foster further understanding of the ways an individual's identity is developed? Does where you, or where your parents were born influence your identity? Does the place you live, your school, your friends shape your identity in certain ways? What about your religion and/or skin color? What do you think has shaped your identity?

Does this routine need to be introduced and all steps incorporated in one lesson? The routine can be introduced and incorporated in one lesson, or in one or more steps over time. The process can be planned or shaped in response to discussions it elicits, and depending on the purpose and context in which it is being utilized. It can be broken into steps in whichever order is most relevant and time frame that is effective, sometimes involving revisiting steps over time.

How can similarities, not only differences, be brought into discussions about identity? Students in the same school can wear different clothes, eat different foods and celebrate different festivals. Often their identities are shaped by their differences, and generalizations are often made that group them with others sharing those attributes. Invite students to find similarities they share. Invite them to look for similarities among students who learn differently to others, among those who come from different family structures, or those who make very different choices in how they spend time away from school, e.g. playing sport, going shopping, playing the saxophone, studying, meeting friends, painting, making things, spending time in hospital, staying alone or with family. Often the many similarities they discover they share are unexpected.

What are some tips for the 'identify' step? You could invite students to role play, introducing themselves to each other as if meeting for the first time, and ask each other questions that would help them get to know each other better. Discuss the multiplicity of identity. Who do people think you are? Can the same person be a sister, a daughter, a student, a swimmer, a blonde, a friend? Where do you think you belong? Is a sense of belonging important? Do you identify yourself in the same way when you meet a good friend, a person you have never met before, a famous person, a person who has an important role in your life, e.g., your teacher, your school leader, your boss, your team captain? Or someone you meet at home, at a party, on a holiday, at a football match, in a restaurant?

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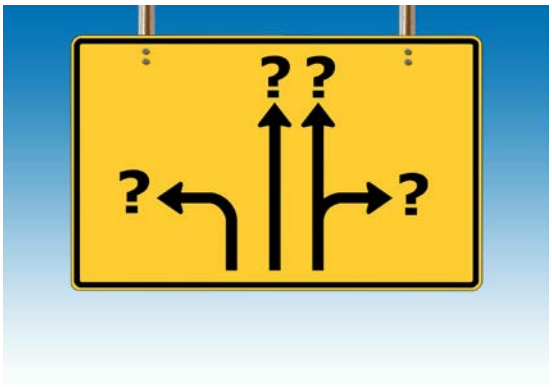
FACTS OR FICTION

A routine to increase awareness of the many issues of truth and what to consider when exploring the truth of something.

By doubting we are led to question, by questioning we arrive at the truth.

Peter Abelard



Select a news item, an image, something that has happened to you, or an event in history.

What do you **perceive** is being conveyed by this?

Who would **decide** to convey this message? Why?

How else could this be **interpret**ed?

What do you **believe** is true in this? What makes you think that?

FACTS OR FICTION : Q & A

What is the purpose of the Facts or Fiction thinking routine*?* Too often, information can be accepted at face value without any supporting evidence. This routine is designed to explore the complexity of the realm of truth. It encourages slow looking, perspective taking, seeking supporting evidence, and analysis to uncover the core and accuracy of information.

What kinds of questions might emerge as students explore Facts or Fiction? For instance, questions like these: Is there supporting evidence? Are many facts and figures reported? Does it fit with what you have learned before? Never be afraid to ask questions.

How can we show students that images or information presented are not always truthful accounts of events? One suggestion is to select an image showing that if only part of it was visible, different 'truths' could be interpreted. Cut the image into separate pieces, show only a part of it at a time as if each piece was a stand-alone complete picture, facilitate a discussion on what can be seen and thoughts/interpretations of what is happening, and then show the complete image and compare with initial thoughts. Alternately, show only one of a sequence of images or read only part of an article initially, discuss it and then complete the sequence.

How can we awaken students to the idea that facts or fiction within a story, image, report can be influenced by the agenda of the photographer, author and/or editor of the information? Identifying possible purposes of a message can provide insights into who is "sending" the message. Why do you think this image/story was communicated? Who would benefit from this 'message' being in the public arena? What impact do you think it may have? After giving yourself, your students, or colleagues time to think about this, ask whether your original impressions changed. What other messages are being perceived? *Circle of Viewpoints* and *Step Inside* could also assist in discussions throughout this routine and highlight different perspectives of the same information/image (these are routines from the Visible Thinking approach– see the end material for sources).

What are the facts? Can there be more than one truth? From a definitional standpoint, in the end there cannot be more than one truth on a particular point, e.g. either smoking doesn't cause cancer or it does (more precisely, heavy patterns of smoking increase the chances of cancer to such-and-such a degree). But there's a big catch to this: what's really true and what we entirely reasonably think is true at the moment are quite different things. What we now entirely reasonably think is true sometimes turns out to be quite wrong later. Also, at a given point in time, different people may take different ideas as true (e.g. one person believes global warming is real and caused by human activities, another doesn't). For some topics, like the causes of an historical event, we may never be in a position really to settle the truth because the information just isn't available. However, it *is* important for students to appreciate that what we reasonably take as true today may turn out to be wrong later, disagreements about what's true are normal, and that sorting out evidence is often a challenging and complex long-term endeavor.

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THINKING WITH IMAGES

UNCOVERING RELATIONAL PATTERNS

Pick a topic / issue / problem. Then, consider the topic / issue / problem in light of the following prompts:

How is this *like*…? How is this *not like*…?

THINKING WITH IMAGES: Q & A

What kind of thinking does this routine encourage? This thinking routine invites learners to use analogical thinking to reason about topics / issues / problems by examining the relations that hold within topic / issue / problem and each image. More specifically, it sets up the conditions for learners to (1) **identify systematic correspondences** between the topic / issue / problem and each image; (2) **draw inferences** about each image in relation to the topic / issue / problem; (3) **evaluate the inferences** for how they might be adapted to fit the qualities of each image; and (4) **consider new ways of thinking** about the topic / issue / problem using each image.

How much background knowledge do students need in order to use this routine? While learners do not need any background knowledge to use this routine, you may want to allow learners some time to think about what they are seeing in each image. For instance, invite learners to quietly jot down their impressions of each image before providing the topic / issue / problem for them to explore.

Should the images be used all at once, or step-by-step? You may choose to have learners work with all four images (this usually supports them in seeing more and more complexity as they begin to compare and contrast the various images), or have them gravitate to the images that call their attention (this supports learners' agency as well as provides information on the images that work well for specific topics / issues / problems), or work with one image at a time (this allows learners to build on preceding ideas as well as systematically develop their thinking).

How else can this routine be used? You may consider inviting learners to design or search for other images that they feel represent or describe their thinking about the topic / issue / problem. Also, having learners reflect on which images work better for the topic and which ones less so is a good way of clarifying and deepening their thinking. Another idea is to invite learners to respond to the images with other images of their choice. This nonverbal way of building on ideas can overcome learners' apprehensions about language, as well as open up a novel way of communicating ideas.

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WHAT CAN BE

HOW MIGHT COMPLEX IDEAS UNFOLD?
HOW MIGHT HUMAN-MADE AND NATURAL THINGS CHANGE?

CHOOSE SOMETHING THAT AFFECTS US AND HAS CHANGED IN MANY WAYS

Review
How did it get to be the way it is now?
Who/what might have caused or influenced these changes?

Predict
How else might this change in the future?

Imagine and Create
Change always comes with challenges. If you could turn the challenges of these predicted changes into opportunities, what do you imagine could be? What could be created?

Consider how things that have been the same or similar for a long time are changing rapidly in our complex world and despite the unknown, how might we plan to positively shape changes ahead?

WHAT CAN BE: Q & A

What is the purpose of the What Can Be? routine? The only constant in our complex world is change. Change can elicit uncertainty and fear, yet change can also provide new opportunities. This routine is designed to encourage exploration of possibilities and to build agency in imagining and creating how things could change and what can be.

When asked to choose something -- "choose something that affects us and has changed in many ways" --, what can be chosen? There are endless possibilities, from objects to systems, human-made or natural, ideas or issues, people and societies or narratives. Encourage your students to make choices too.

When there appears to be no need for change, why consider possible changes? Do we stay with the saying, 'If it ain't broke, don't fix it', or do we look for ways to improve what we have? The Review step (seeking to identify how today's objects, ideas, systems and narratives came about in the first place, and what caused changes along the way) can help develop understanding of why beliefs that have been held and objects created have changed. This in turn reveals how they might be developed further or new creations built on what has been learned from past experiences. Why are schools in so many ways the same as when our grandparents were at school? What changes could be made in schools for a better fit for growing up in our changing world?

What are some examples of change? **Mobility and transportation**. From people initially moving on two legs and carrying in hands → riding on animals → creation of wheels → motors → on land → on and under water → in air → to outer space > ???. **Health care**. Lying down when ill → herbal remedies → prevention, pasteurization → antibiotics → surgery → transplants → 3D printing of body parts → ???.

Any tips to encourage students to be risk takers and try the unexpected? History provides many examples of people trying something differently and persevering when things went awry. A fun and engaging way to encourage students to think about what can be could be to look at accidental discoveries such as, A dog invented Velcro. "Alright, that's something of an exaggeration, but a dog did play an instrumental role. Swiss engineer George de Mestral was out for a hunting trip with his pooch, and noticed the annoying tendency of burrs to stick to its fur (and his socks). Later, looking under a microscope, Mestral observed the tiny "hooks" that stuck burrs to fabrics and furs. Mestral experimented for years with a variety of textiles before arriving at the newly invented nylon — though it wasn't until two decades later that NASA's fondness for Velcro popularized the tech." *(*The 10 Greatest (Accidental) Inventions of All Time) How many children and parents are grateful for shoes fitted with Velcro rather than shoelaces? What else could be that would help people?

How can Step Three, Imagine and Create, be utilized? Objects and situations can be accepted as is, status quo! But how else could they be? What Can Be is designed to encourage the freedom to imagine possibilities. The creative process can involve solving a problem, creating an alternative, making something new or an exploration of options. These learning opportunities can include using found or available materials that could be discarded, and/or specifically selected materials, and time given for imagining how else they could be, to dream, plan and design. New or adapted objects and/or systems can be created individually, in groups or as whole class activities.

How can predictions be made when so much is unknown? The word "predictions" encourages safe risk taking. It is not expressing certainty of what will be, rather forecasts, likelihoods and projections, and therefore worth exploring what could happen with the aim of providing positive options ahead, or, if predictions are not so positive, giving time to seek alternative ways ahead.

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SAME AND DIFFERENT

ARE THEY ALWAYS MUTUALLY EXCLUSIVE?

Consider why things are often seen as right **or** wrong, black **or** white, up **or** down, plus **or** minus; nearly always **either/or**. Can they be the same **and** different?

Choose a debate, incident, or object in which opposing views are clearly apparent, or images that look different but are grouped together.

Notice
Often judgments are made at first glance.
What was the first impression you had about this?

Perspective Taking
From what other points of view could this be perceived?
What would one say from those points of view?

Same and Different
What are the similarities? Differences?
How is this case the same and different at the same time?

SAME AND DIFFERENT : Q & A

What is the purpose of the Same and Different routine? It's to help learners go beyond the surface of similarities and differences. Complex matters are often presented and accepted as is. It's not until they are questioned and explored more thoroughly and deeply and from different angles that they can be better understood and more thoughtful opinions and decisions made.

What are some examples of when the same can be different? Sometimes language represents this. The word curriculum can have at least three different meanings: the curriculum taught, the curriculum learned, the written or state curriculum. So what does it mean when we say that the curriculum has been covered? -- what has been prescribed, what has been taught, what has been learned? For other examples, one sometimes finds the same image in different newspapers yet with very different stories. The same sunlight can be referred to as both positive, a source of Vitamin D, and negative, can cause skin cancer. The same length of a school day can be viewed very differently from the perspectives of teachers, students, parents and school leaders.

How can we assist our students in realizing their thinking has changed over time and not feel guarded about admitting they have changed their mind? Give examples of how highly regarded scientists changed their views about the impact of sugar in diet as they learned more about the way bodies function and respond to different foods and combinations of foods. You can also model how your ideas have changed and how and why this happened and assure students that their thoughts are valued, not judged, and provide time for reflection. The thinking routine *I Used to Think and Now I Think* can assist with this. (this routines is from the Visible Thinking approach – see the end material for sources).

How does this routine connect to schools and classrooms? Even very young children can be heard saying, "That's not fair!" But do equal and fair mean the same? Does chronological age mean people of that age are the same height, have the same skills and vision and hearing? If they are treated equally and all given the same books to read, is that fair for the child who has poor vision? When we study history and the lives of famous people, did the individuals held in high regard in different countries have the same record of military achievements or ways of ruling? What did they do differently? Same and different are constant puzzles. Different countries have different currencies, different homes, schools and languages, yet they all share the same or similar purposes. Words can sound exactly the same as another, yet be spelled quite differently, and have very different meanings. People can be grouped together or separated because of one or more of the following: religion, skin color, education, socio-economic status, background, country of birth….. Yes, all are different in some ways, but what is the same about all people?

Oher suggestions? The book, Paradox of Choice by Barry Schwartz provides many examples and stories about same and different and this can assist students in making connections with their world. E.g. Schwartz begins with talking about going into Gap to buy jeans and told the salesperson his size. She replied "Do you want them slim fit, easy fit, relaxed fit, baggy or extra baggy……stonewashed, acid-washed, or distressed? Do you want them button-fly or zipper-fly, want them faded or regular?" He was stunned. He just wanted jeans. When people talk about jeans, we assume we are all referring to the same item, yet is that so? When there is talk about a government decision being fair, is it fair for everyone?

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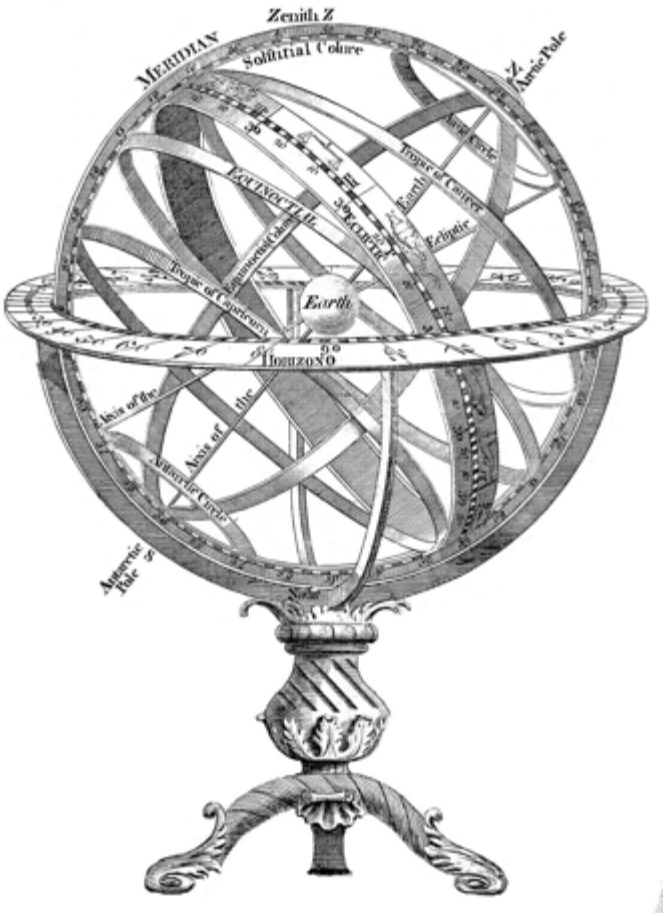
Acknowledgements & Further Resources



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This bundle on transfer of learning is one of four related Visible Thinking bundles, all produced with the generous support of Independent Schools Victoria of Victoria State, Australia, Chief Executive Michelle Green. Warm thanks to Michelle and to Independent Schools Victoria for making possible the development of these materials.

The four bundles include:

- *Global Thinking*, which offers thinking routines fostering understanding and appreciation of today's complex globalized world.
- *Pathways to Understanding: Developing Students' Memory & Note Taking Skills*, which leverages contemporary understandings of how memory works to advance both memory for and understanding of content.
- *Portable Knowledge*, which helps learners transfer what they learn in particular subjects to other contexts and studies far and wide.
- *Exploring Complexity*, this bundle.

VISIBLE THINKING IN GENERAL

Exploring Complexity is a bundle of ideas and thinking routines about complexity that reflects the general approach of Visible Thinking. Visible Thinking provides a research-based method to integrate the teaching of thinking flexibly into content learning, a method that both deepens content learning and fosters the development of thinking skills and dispositions. The approach has been developed over a number of years at Project Zero of the Harvard Graduate School of Education by several researchers including the present authors, with the participation of several schools and funding from multiple sources, including Independent Schools Victoria (ISV) of Victoria State, Australia. Warm thanks to ISV for supporting the development of these materials specifically.

Besides *Exploring Complexity*, Visible Thinking offers many other thinking routines and ideas addressing various aspects of thinking and learning. There are two websites: http://www.visiblethinkingpz.org/VisibleThinking_html_files/VisibleThinking1.html and http://pzartfulthinking.org/.

Independent Schools Victoria from time to time offers a three-session general online introduction to Visible Thinking, called *Visible Thinking.*

Two books by Ron Ritchhart and colleagues present a version of Visible Thinking that emphasizes cultures of thinking: *Making Thinking Visible* and *Creating Cultures of Thinking*. Online courses from the Harvard Graduate School of Education offer an introduction: *Visible Thinking* and *Creating Cultures of Thinking* – see https://www.gse.harvard.edu/ppe/programs/online. Veronica Boix Mansilla has also pursued work related to complexity – *Global Thinking Routines* – using the Visible Thinking model.

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FURTHER ROUTINES FOR COMPLEXITY FROM VISIBLE THINKING

In addition to the thinking routines in *Exploring Complexity*, several other thinking routines from the broad repertoire of Visible Thinking address various aspects of complexity. These include, just for a sample, *Circle of Viewpoints*, which engages learners in looking at a situation from multiple viewpoints, *Generate-Sort-Connect-Elaborate* about concept mapping, and *Tug-Of-War* for charting out complex arguments. We have composed this package out of fairly new routines, but certainly educators are welcome to reach for others from Visible Thinking or indeed to make up their own, which teachers often do.

AN APPROACH TO CAUSAL COMPLEXITY FROM PROJECT ZERO

Dr. Tina Grotzer of the Harvard Graduate School of Education and her colleagues have sustained a line of research and development for many years on *causal complexity*. This approach focuses on the kinds of complexity that arise around scientific phenomena. For instance, causal complexity includes effects that are remote from their causes in space and time, mechanisms of equilibrium where it looks as though 'nothing is happening' but a dynamic mechanism is at work, probabilistic aspects of causality, and several more. The present package lightly represents some of these matters, but readers can find much more of the deep dive in Tina Grotzer's work. A key source is her book *Learning Causality in a Complex World.* Also, there is a considerable collection of resources about causal complexity that can be downloaded: http://www.pz.harvard.edu/resources/learning-causality-in-a-complex-world-understandings-of-consequence.

OTHER APPROACHES TO COMPLEXITY

In the academic and educational literature and in various lines of inquiry, a number of other ideas address various aspects of complexity. Without attempting a thorough survey, some examples include...

- Systems thinking, including ways of modeling complex systems, for instance with arrow diagrams, that capture features such as escalating and de-escalating loops.
- Complex adaptive systems, as in living organisms, societies, and economic systems, that adjust in various ways to internal and environmental challenges.
- Chaos theory, which looks at phenomena like the weather or biological evolution with an eye both to systematic trends and fundamental sources of randomness and variability that make precise prediction impossible.

As these notes demonstrate, complexity is itself complex! We hope that *Exploring Complexity* will provide educators and their students with an accessible entryway, offering tools that can be applied readily to almost any area of content and encouraging further confident ventures into the many worlds of complexity.

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