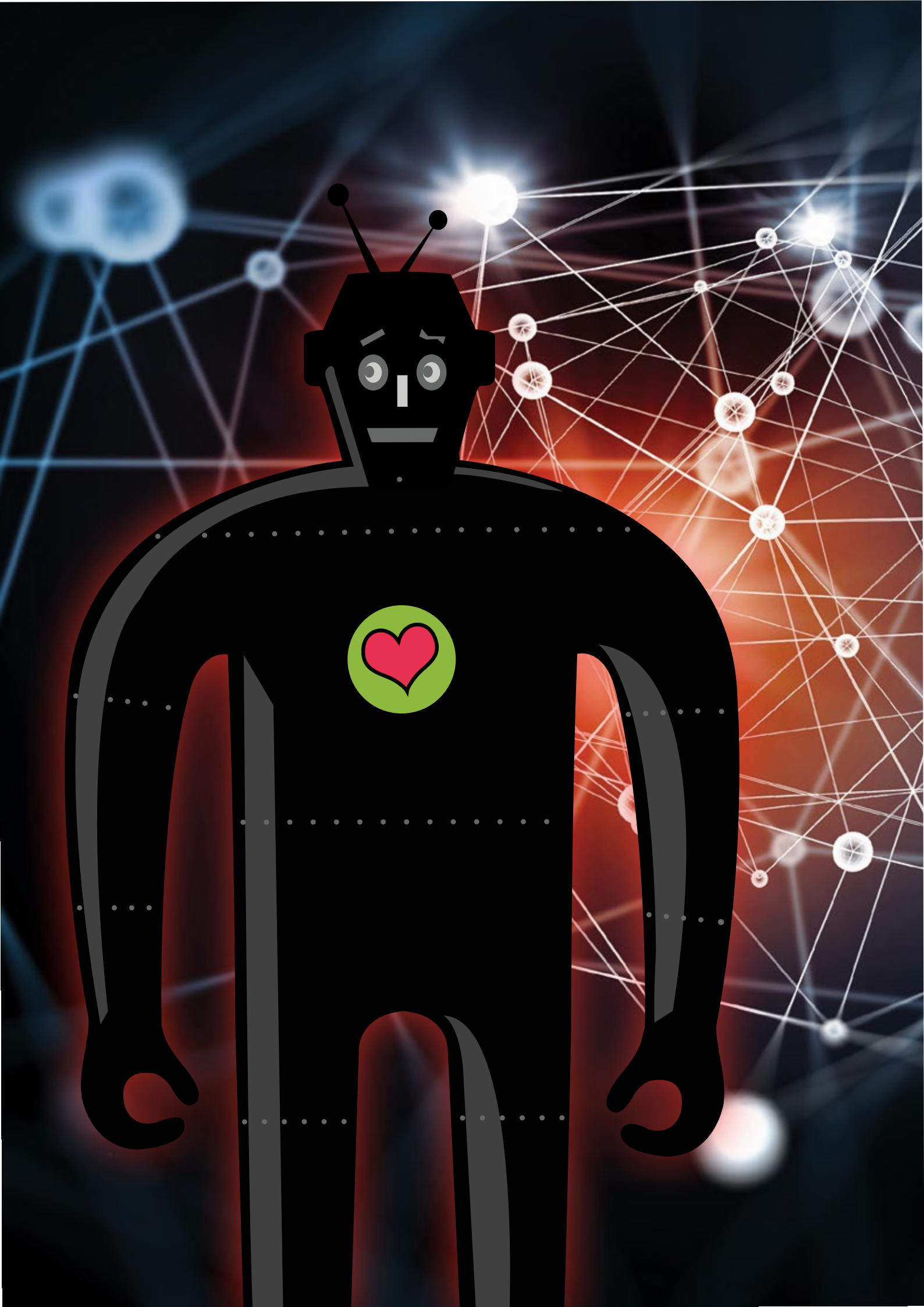
Epistemic Insight

A GUIDEBOOK TO BUILDING PERMEABLE CLASSROOM WALLS IN SECONDARY SCHOOLS

Creating an epistemically insightful learning experience to develop students' understanding of disciplines and how they interact

FACULTY OF
ARTS, HUMANITIES
& EDUCATION

Canterbury Christ Church University



CONTENTS

HOW TO USE THIS GUIDEBOOK

This guidebook has been designed to support teachers, teaching assistants, education practitioners and ambassadors taking part in the Permeable Walls research project or secondary CPD. The research and CPD examines how scholarly thinking, questioning and disciplinary knowledge can support students to understand how different disciplines interact to provide richer answers to questions and better appreciate the nature of science in real world and multidisciplinary contexts.

However, you can still use this guidebook individually or as a team to consider how you can support your students to be more epistemically insightful and understand how their curriculum subjects relate to each other and the "real world".

This guidebook contains information about the Epistemic Insight Initiative, the learning experiences the can be created through exploration of the curriculum intent, and practical exercises and tools that you can implement in your classroom.

Throughout this guidebook you will find short activities that are designed to deepen your understanding (and sometimes challenge misperceptions). The activities and following reflections are there to support you to develop (or make explicit) an epistemically insightful curriculum for your students.

If you are using this book alongside the research project or CPD many of the activities will be used as prompts or developed further as you work with us. The activities can be explored individually, as a team (department/ key stage/whole schools) even if not everyone is attending the seminars.

This Guidebook has been written using examples from the UK Government National curriculum for students in Key Stage 3 (age 11-14) and Key Stage 4 (age 14-16) however the activities and pedagogy can be adapted (if necessary) for Scotland and Ireland as well as internationally. If you would like to understand how this could work for your curriculum, please get in touch.

Keep an eye out for the "thinking like a scholar…" Owl that emphasizes the scholarly thinking you would want to focus on with your students to explore similar concepts.

If you are interested in exploring the ideas in this book further by becoming a research partner, please get in touch at **lasar@canterbury.ac.uk**

I can think like a scholar when I can...

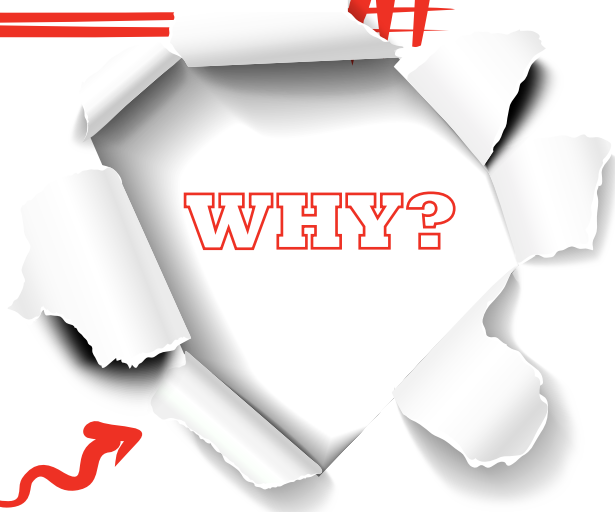
- explain how different disciplines investigate a question
- illustrate how another discipline is diferent to science

ep·i·ste·mic in·sight (ĕp′ĭ-stē′mĭk ĭn′sīt′)

Epistemic insight refers to 'knowledge about knowledge', and particularly knowledge about disciplines and how they interact.

Gaining epistemic insight is about developing an appreciation of the strengths and limitations of individual disciplines. One way to do this is to explore how two disciplines each investigate a cross-disciplinary question. Consider for example how science and history can each investigate *'Why did the Fire of London spread so quickly?'*

BIG QUESTIONS



Today's Big Questions include:

- **Can a robot be a good companion?**
- **Can and should genetic engineering be used to make better people?**
- **Why do life and the universe exist?**

Big questions are frequently squeezed out of school education. That's because they don't fit neatly into one subject, they are often religiously sensitive and they call for teachers to explain how science and other areas of knowledge interact.

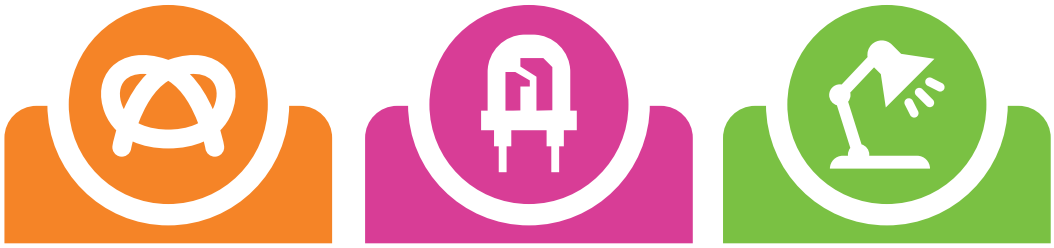
Comparing how different disciplines ask and investigate questions is often not covered at school

And yet these are questions where great advances are being made and where outputs affect the lives of individuals and society.

Look what happens when you include these objectives and students learn about the nature of knowledge...

THE EPISTEMIC INSIGHT CURRICULUM FRAMEWORK

The objectives below are from the Epistemic Insight Framework. They are statements about the nature of scholarship and knowledge that reflect the aims of the National Curriculum.



LEARNING OUTCOMES	Relationships between science and religion	The nature of science in real world contexts and multidisciplinary arenas	Ways of knowing and how they interact
UPPER PRIMARY	Science and religion are mostly concerned with different types of questions, including different types of why question.	Science begins with observations of the natural world and constructing ways to explain our observations. Some methods are more scientific than others.	Science has some similarities and some differences with other ways of knowing that we learn about in school.
LOWER SECONDARY	Today we ask big questions about human personhood and the nature of reality that bridge science and religion. Some people say that science and religion are compatible and some people say they are not.	Science informs our thinking about every aspect of our lives. Some questions are more amenable to science than others. There are some questions that science hasn't yet and may never be able to answer.	A school is a multidisciplinary arena. Different disciplines have different preferred questions, methods and norms of thought.
UPPER SECONDARY	Science and religion are not necessarily incompatible.	Scientism is not a necessary presupposition of science.	Some questions are more metaphysically sensitive than others.

Billingsley, B., Nassaji, M., Fraser, S., & Lawson, F. (2018). A Framework for Teaching Epistemic Insight in schools. *Research in Science Education*. https://doi.org/10.1007s11165-018-9788-6 (Open Access)

INTRODUCTION
WHY EPISTEMIC INSIGHT MATTERS

ABOUT THE EPISTEMIC INSIGHT INITIATIVE

What insights do we expect young people to call on when they address the big questions of life and the universe?

How can schools prepare young people for a world facing false facts and exaggerated headlines, and equip them with the best ideas and strategies to make informed decisions rationally and compassionately?

What strategies can schools use to develop young people's expressed curiosity about the nature of reality and human personhood, and give the future great minds of science and other disciplines the inspiration and stimulus they need?

Epistemic Insight is knowledge about knowledge – particularly knowledge about disciplines and how they interact. It is both a pedagogical approach and an intellectual virtue that is teachable & assessable.

The entrenched subject compartmentalisation of secondary school teaching can provide challenges for students' understanding of how the different areas of the curriculum are related to each other and to real-world contexts. By studying across subject boundaries students can deepen their understanding of cross-disciplinary responses to many of their questions and encourage active enquiry into the power and limitations of different responses and solutions. Epistemic insight goes hand in hand with teaching a broad and balanced curriculum: it brings to life the 'purpose of study' section in each national curriculum subject by helping students to recognise what is distinctive about each discipline - and its preferred questions, methods and norms of thought.

We live in a fast-changing world. The Epistemic Insight Framework is a meaningful and relevant approach that builds on current teaching practice where learning is planned, delivered and assessed through alignment to epistemic insight pedagogy. Highlighting the similarities and differences between disciplines within a multi-disciplinary arena.

Teachers can support students to answer these three questions.

- How does a discipline interpret the question?
- What methods would this discipline use to investigate the question?
- How would a scholar of this discipline know they had a good answer?

When students are able to do this, they are epistemically insightful.

THEORY OF CHANGE

The Epistemic Insight Initiative involves more than ten Higher Education Institutions across England, led by Canterbury Christ Church University, with funding from The Templeton World Charity, Uni Connect (formerly the National Collaborative Outreach Programme), All Saints Education Trust and a range of other funders supporting smaller focused aspects of the research.

We are working across Initial Teacher Education, the Schools and College Engagement Team at the University and directly with schools, teachers and educators. This allows us to collaborate, co-create and develop research and practical classroom pedagogy and teaching tools that will develop and support students' expressed curiosity about Big Questions and understand how these can be used to capitalise on the curriculum intent.

Additionally, the work directly with schools and teachers is designed to provide opportunities for dialogue about questions that bridge subjects and disciplines and understand how this can work in a range of learning environments and across age groups.

By collaborating across age groups and subjects, we are researching ways to help students to progress towards a greater understanding of the nature of science, religion and the wider humanities and their relationships.

The work is helping schools to:

- Develop students' curiosity and capacity to express questions that bridge disciplines and subjects including Big Questions (those about the nature of reality and personhood that bridge science, religion, and the wider humanities).
- Support teachers to express the implicit curriculum and understand the shape of disciplinary knowledge across the curriculum so that this is shared with their students, who are then better equipped to understand disciplines in real world contexts.
- Explain the characteristics, potential and limitations of a range of disciplines and areas of knowledge. To show how they interact to inform our thinking about different types of questions and why the framing of questions matters.
- Develop (and evaluate) enquiries that demonstrate a growing ability to think more deeply, compassionately, and rationally about Big Questions
- Equip students' to be independent, critical, and engaged scholars who have a rich understanding of the power and limitations of different disciplines to inform our thinking.

I can think like a scholar when I can...

- explain how different disciplines help me to investigate a Big Question
- explain what makes a question amenable to scientific enquiry

ACTIVITY 1: DEVELOPING KNOWLEDGE: A MULTI-DISCIPLINARY APPROACH

How is tea made?

Different disciplines address a question by drawing from their unique 'ways of knowing': different methods, norms of thought and types of questions.

Select two different disciplines to investigate this question and explain your rationale.

(you can use the discipline wheel on p57 to support this)

For example:

- The mathematics of tea making
- The science of tea making
- The art of tea making
- Tea making in different geographical locations

ACTIVITY 1: REFLECTION

Why did you select your disciplines?

Was it because they contrasted? Do you have a greater familiarity or confidence with mathematics over art? Or did the science of tea making seem easier to explain than the mathematics?

Much of this selection process happens in the background of our curriculum and lesson planning, we may choose an experiment because it is trusted, cheaper, easier to explain (or any other number of reasons). But what students often perceive is that it is the ONLY way to investigate the topic.

How might other disciplines add to the investigation?

Look at the answers you gave. Do you think that they provide a **full** account of "how is tea made" or are you still missing details or important aspects? If you don't feel like you have a full explanation, we would say that the disciplines you have examined **inform our thinking** about tea making but don't fully answer the question.

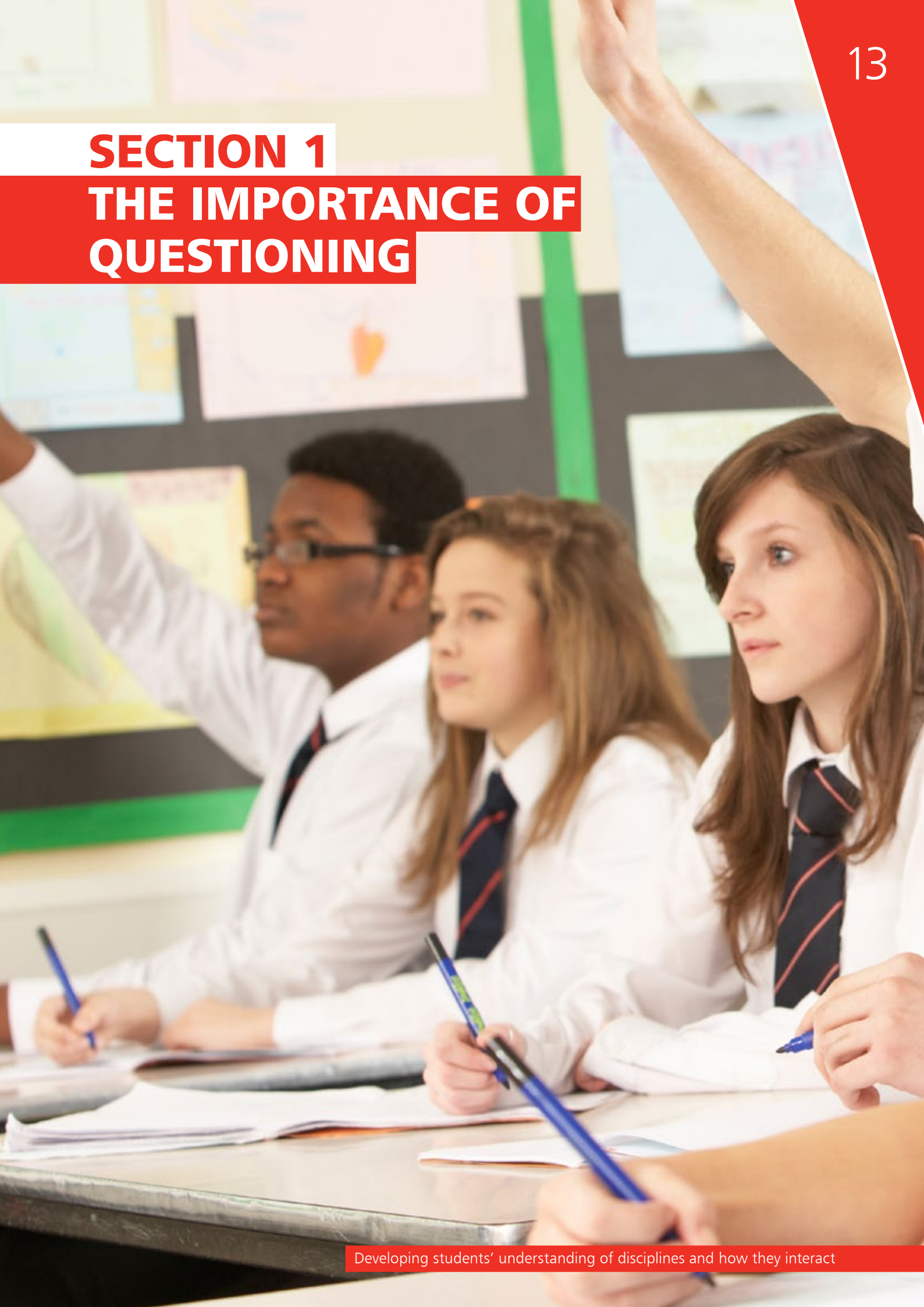
Providing students with this language can help students to understand and express the limitations of answering bigger questions using a single disciplinary lens. It can also be used to explore the concept that there are often smaller questions that can be fully answered within a single discipline – not every question is multidisciplinary!

What strengths and limitations can you outline for each discipline?

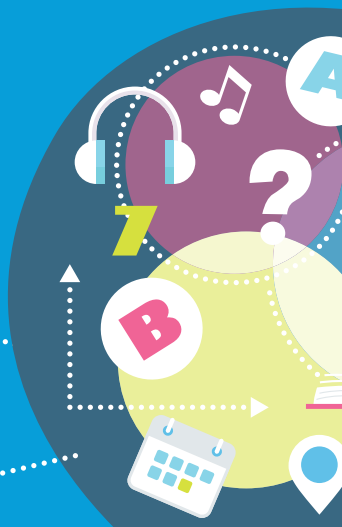
As we move through the guidebook we will look in more detail at different ways of knowing. For now, consider your responses. We are going to focus on the strengths and limitations of the disciplines. Once you and your students are more confident methods, questions and norms of thought can be drawn into the discussion of strengths and limitations.

What aspects of tea making did the disciplines manage well and where did they struggle? Recognising the strengths and limitations can help students to see that knowledge from different disciplines helps them to build a richer understanding of the question they are answering. As well as becoming aware of when a small question can be fully answered within a single discipline.

SECTION 1
THE IMPORTANCE OF QUESTIONING



BECOMING MORE SCHOLARLY



WHAT DOES TEACHING EPISTEMIC INSIGHT LOOK LIKE?

The boxes below show some of the reasons and ways that we are proposing to help our students at school to become epistemically insightful.

Thinking like a scholar in KS1

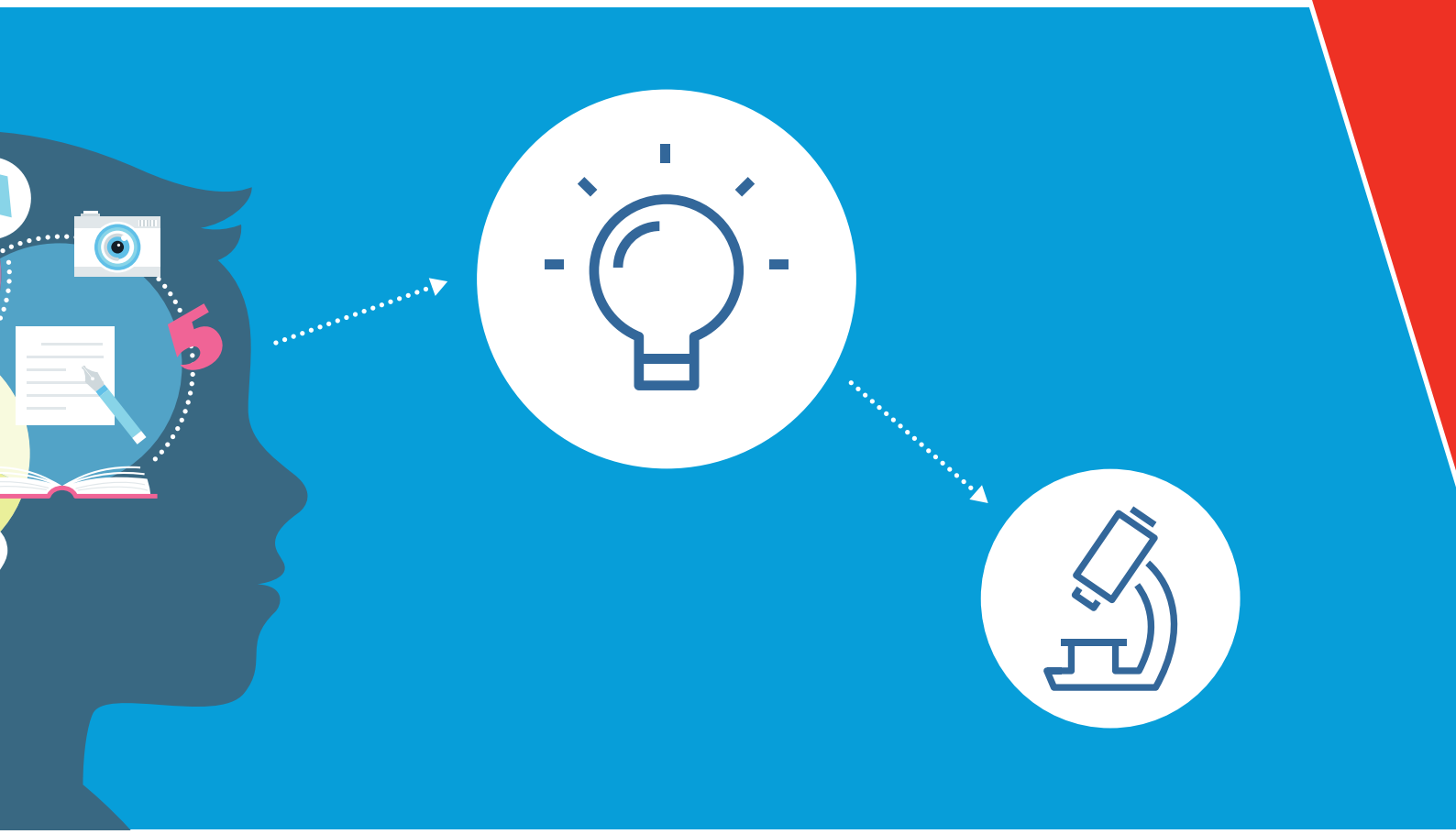
At school we learn about scholarly knowledge and how to think like a scientist, historian, geographer, musician…

Students sort books into their disciplines using the discipline wheel, they practise creating scholarly knowledge and research scholarly ways of finding out.

How scholarship works in KS2

At school we learn about questions that bridge two disciplines, like "Why did the Titanic sink". We learn that two disciplines can work together to give us a bigger picture – and what we miss if we miss one perspective out.

Students wise up to the complexities of developing knowledge within disciplines and across them by framing, investigating and analysing different types of questions. One day some of our students will be scholars themselves. Many others will also be in professions that produce or apply or test or examine or teach or write about knowledge.



Scholarly conundrums In KS3

At school we learn that each of the disciplines has its preferred questions, methods and norms of thought. Science seeks to explain phenomena in the natural world and is required to argue on the basis of observations that are objective and repeatable. That is both a strength and also a limitation. We see that different people find different types of questions interesting.

The idea that knowledge is limited is a hugely important epistemic insight. Some scientists use the phrase, sufficient truth, to explain that science can give us a high level of certainty within the boundary or frame in which we are working.

Scholarly thinking in KS4

We appreciate that scholars are likely to reach a consensus on some questions – like why does a pen fall to the ground. Some questions are more individual and contentious – like why people do what they do. We consider reasons why knowledge changes over time and also why the nature of science changes. Before vitamin tablets – there wasn't much call to work out whether too much of any one vitamin can cause you harm!

Students examine their own and other people's perspectives on the power and limitations of science.

FRAMING THE CHALLENGE

Educational research is focused on the question "How can we make education better?" The Epistemic Insight Initiative and curriculum framework are not intended to replace or compete with the National Curriculum, but instead to make the curriculum intent (and sometimes content) more explicit and visible for all our young people.

We know that topic-based work can sometimes leave students unclear about the distinctive contributions from different disciplines and lead to a focus on content not intent. For many students this relates to how they are "labelling" their learning experiences. We may plan engaging learning opportunities for our students but if they aren't either (a) clearly labelled or (b) we haven't equipped students to recognise that the methods they're using or the questions they're examining are associated with a particular discipline, they may struggle to recognise which discipline they are investigating. Equally, the compartmentalisation of the curriculum becomes more pronounced as students move through secondary and post-16 education. This produces the converse issue of not highlighting how the disciplines interact. Without this understanding they may struggle to understand how their subjects relate to each other, but also to recognise that many of these curriculum subject boundaries are "fuzzy" in real world contexts.

SUBJECT COMPARTMENTALISATION

For many decades the practice at almost every level of education has been to teach students about scholarship and knowledge via a compartmentalized system of subject boxes. Even where students are taught through a topic based curriculum this is often run in contrast to distinct lessons in English and Mathematics, sending implicit messages about the value of the "other" subjects that don't get their own "box".

This entrenched compartmentalisation emphasizes subject boundaries without explaining links to other disciplines and developing understanding of the strengths and limitations of each discipline. This pedagogical engineering has constructed barriers to the development of epistemic insight and scholarly thinking and led to "gaps, confusions and misperceptions in students' reasoning" (Billingsley & Arias, 2017). Epistemic Insight is about equipping students to be able to address these boundaries: Why are they there? What information can or should cross those boundaries and how does crossing the boundary change what that information/ knowledge/ vocabulary looks like?

DIGITAL "COLLAPSE" OF BOUNDARIES

In this 'digital' age, it is important to equip students with the skills to be rational and compassionate thinkers. By developing epistemic insight as well as mastery of content skills and knowledge, students are better equipped to navigate their education and future career choices successfully. Through actively working to build their understanding of school as a multidisciplinary arena, we can equip them for the challenges and issues they will be addressing in their working lives which increasingly will not be tackled by one discipline in isolation.

There are incredible opportunities presented by online and blended learning, as well as opportunity for students to access a wealth of information to support their learning. However whilst we as adults may be aware of the need to carefully frame questions before entering them into an online search to retrieve relevant results, our ability to sort the information being received is based on our own implicit understanding of both the strenths and limitations of the disciplines and also the preferredquestions, methods and norms of thought that shape the different disciplinary responses. This is a different question to being able to recognise safe websites, "false facts" and valid online sources. The digital collapse of boundaries eliminates clear signposting of individual disciplines and their preferred uestions, methods and norms of thought.

ACTIVITY 2: GOOGLE IT!
DIGITAL COLLAPSE OF BOUNDARIES

What is a footprint?

1. Undertake an internet search for the question. Apart from dictionary definitions How many disciplinary approaches can you find in the first 2-3 pages of results?
2. Choose 3 different interpretations or disciplinary approaches.

ACTIVITY 1: REFLECTION

What clues, cues or additional information did you use to recognise the disciplinary perspectives?

Consider how much of your ability to recognise the disciplines was based on your prior knowledge, either disciplinary such that you already knew digital footprints are associated with computing, or real-world context you have heard enough about carbon footprints to know they have broader contributing factors than science alone such as ability to pay more for local food to reduce air miles etc.

Think about how you can support your students to recognise similar clues. Whilst some of these may be visual a lot of them rely on our understanding of the methods or norms of thoughts associated with different disciplines and these aren't always clear to students.

Thinking about your students, how might they approach this same task?

There are two key issues to consider, the first is that there are a wide range of different "footprints" ecological, carbon, physical etc. these can offer opportunity to contrast interpretations. Secondly, it is possible to investigate different approaches to the same "kind" of footprint.

Footprints offer a really rich opportunity for examining different disciplines. These could include investigating how how our shoe footprints reflect how we walk. For older year groups it might involve looking at the "footprints" poem, or footprints in art and thinking about what they symbolize. This doesn't have to be examined using a lot of text, you can get a similar breadth of results from an image search. Finally, you could choose to examine a multidisciplinary "footprint" such as ecological footprint and investigate how different disciplines could inform our thinking about what is needed to reduce our impact.

WHAT DOES THIS MEAN? AND WHERE DOES THIS FIT WITH THE CURRICULUM?

Understanding the difference between curriculum content and curriculum intent is an important part of epistemic insight for educators. Focus on the curriculum content can mean that we lose sight of the intention of the curriculum. The "purpose of study" can seem a long way from classroom practice, but it can also help students to understand why each discipline matters and how they relate (and in some cases overlap). How do we share this in an accessible way with students?

The science national curriculum provides an excellent example of how the intent can be missing from the content and lead to a lack of clarity for students.

asking simple questions and recognizing that they can be answered in different ways

asking relevant questions and using different types of scientific enquiries to answer them

asking their own questions about scientific phenomena

become aware of some of the big ideas underpinning scientific knowledge and understanding

develop understanding of the nature, processes and methods of science [...] that help them to answer scientific questions about the world around them

Note there is an implicit assumption – written into the purpose of study, but not captured in the content "to develop a deeper understanding of a range of scientific ideas in the subject disciplines of biology, chemistry and physics. Pupils should begin to see the connections between these subject areas and become aware of some of the big ideas underpinning scientific knowledge and understanding." (NC). For many students the nature of questions that can be answered by science remains unclear – whilst they may have a firm grasp on the concept of a "scientific method" this can be disconnected from the preferred questions and norms of thought (values) that make a question amenable to science.

ACTIVITY 3: GOOD QUESTIONS: HOW DO WE KNOW WHAT TO ASK?

The previous activity focused on recognising different disciplinary interpretations of the same question. This activity focuses on what makes different disciplines distinctive, and how we are able to recognise this.

Put each of these questions in the center of a Mind Map - and try to capture an answer or set of answers. Undertake this activity twice first thinking how you would answer this for yourself, then how you would answer this for a student in your class(es).

If you are undertaking this activity as a group, you may want to look at the questions in smaller groups or using a silent debate to challenge each others' assumptions.

1. What makes a question a good question for science to answer?
2. What makes a question a good question for geography to answer?
3. What makes a question a good question for history to answer?

I can think like a scholar when I can...

- explain how different disciplines investigate a question
- illustrate ways in which disciplines are similar or different

ACTIVITY 3: REFLECTION

What is your focus for each discipline?

Have you focused on curriculum content - Emphasizing the "kinds" of things that each discipline deals with? Have you looked at methods – how the disciplines arrive at their answers? Or have you posed questions that the discipline could answer?

These are all common responses to this activity, and it can be difficult, even as teachers and educators to precisely think about what makes something a good question for a discipline. The content is the "easy win" but it doesn't tell us what makes it a good question for the discipline. This returns to the "purpose of study" and the need to capture what is distinctive about each discipline (although this may also include questions, methods and norms of thought examined next). The clearest explanation is to focus on the norms of thought (or what each discipline values).

Looking for relevant questions?

Many people find this activity difficult, even though we are educators and understand what is grouped in to a curriculum subject. This highlights the importance of supporting students to understand what makes a question relevant.

Think about what this might look like with your students, and how this activity can be used to explore what links the questions or ideas (this can be done be encouraging the students to explore common themes if they come up with lots of content questions). For example, we might be tempted to say that geography deals with "questions abut the world". Consider this "why is the world here?" is not a good question for geography to answer – why is that, and what disciplines may be better placed to inform our thinking about this question?

Thinking About Student Responses

When you answered this from your students' perspective did you come up with different answers? Do you think they are picking up on the implicit curriculum intent? Would they find it easier to answer for a discipline like science or something else?

The aim of this, when explored with students is to encourage discussion. Content retrieval can be praised, and then they can be supported to "think like a scholar (be epistemically insightful)" by exploring what links the different content topics. Particularly with science, students may already recognise the method, and this can be used to support exploration of preferred questions and norms of thought, or to act as a starting contrast to think about another discipline.

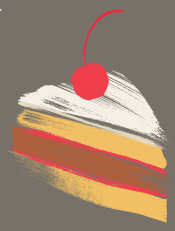
SECTION 2
WAYS TO TEACH EPISTEMIC INSIGHT

DISTINCTION BETWEEN SUBJECTS AND DISCIPLINES

This section focuses on developing your understanding of what this looks like in practical terms in a school classroom, how it sits alongside the requirements of the national curriculum and introduces some simple tools that be brought in to any of your teaching.

Teaching epistemic insight includes teaching students how to work with questions that are framed and explored by one discipline as well as those that are multidisciplinary. Multidisciplinary questions include Big Questions that touch on the nature of reality and human personhood, but they also include questions that bridge only two or three disciplines.

Epistemic Insight focuses on disciplines, not subjects, this is important because whilst students are used to working in subjects, subjects only exist in schools and colleges. They have been engineered to deliver key aspects of a discipline that provides a firm foundation, or what is perceived to be pertinent content. This selection of material means that sometimes the subject studied at school can look very different to the discipline out in a real-world context. The subject can be thought of a small slice of the disciplinary cake.



Subjects also have been designed to have quite clear boundaries, whilst the water cycle may appear in both science and geography in general curriculum subjects don't echo the woolier boundaries between some disciplines. However, the apparent firm boundaries between subjects enable misconceptions about how disciplines inform our thinking, as well as their strenghts and limitations.

I can think like a scholar when I can...

- explain how a discipline's preferred methods may influence the answer it provides
- illustrate how another discipline is diferent to science

DEVELOPING QUESTIONS

Disciplines have preferred methods, questions and norms of thought. These can be captured through the three questions below. The most difficult to explain can be the norms of thought. This can be explained to students by saying that different scholars have different things that they value in their discipline. This helps them to know if they have arrived at a good answer. For example, a "history" answer that focused on current events wouldn't be dealing with what history values (people and events in the past).

If students are able to answer these three questions, they have a good understanding of what a discipline is. Students who are able to respond to the "thinking like a scholar" statements, and the poster statements on p. 59 will also have a good understanding of disciplinary knowledge.

How does my/this discipline understand the question?
(Questions)

How does my/this discipline investigate the question?
(Methods)

How would my/this discipline know it has a good answer?
(Norms of Thought)

How can I make a better answer?

BIG QUESTIONS AND BRIDGING QUESTIONS

Both Big and Bridging questions provoke multidisciplinary responses, however there are significant differences between the two. Because of the nature of Big Questions they are often questions that science, religion and other disciplines have something to say. However, they are also questions that whilst they may be informed by multiple disciplines, we are unable to arrive at either a definite answer or a consensus – for example "What does it mean to be a person?" or "why is the world here rather than nothing at all?". Students often express their curiosity about these questions and discussion of them can form an excellent part of an epistemically insightful classroom and allow students to examine a whole range of issues that arise where science and religion meet.

Big questions can be broken down in to smaller questions that are more amenable to different disciplines and where we may be able to arrive at definite answers to inform our thinking about the Big Question.

These questions may also deal with issues that are more sensitive for some students due to the science and religion links. Due to the nature of Big Questions it can be difficult for students to clearly understand how the methods, questions and norms of thought of different disciplines discretely inform our response (it may feel like there is a lot of overlap).

Bridging Questions are pedagogically engineered to highlight the similarities or differences of how (usually two) key disciplines interpret or investigate a question.

They are designed to act as a teaching tool and whilst a Big Question may be used, bridging questions don't have to touch on the ultimate nature of reality or personhood and so can be started in any curriculum subject.

EXPLAINING DISCIPLINES IN THE CLASSROOM

Linking disciplines to scholars e.g. historian, scientist etc. can help students to understand that what they do in the world, might be very different to what the subject looks like in school. However, it is important to be careful as students progress that they don't conflate disciplines and careers. Using Bridging Questions to frame students' enquiry provides a useful tool to also develop their understanding of different ways of knowing across disciplines, as it it enables them to practically investigate how their answers differ depending on the disciplinary lens they are using. This can be achieved by students exploring both approaches together as a whole class, or by different groups in the class exploring different disciplinary approaches (this could include multiple groups exploring 2 disciplines) and then coming together to explore the different answers that they have arrived at.

FRAMING BRIDGING QUESTIONS

Bridging questions can be designed to show how different disciplines apply contrasting norms of thought (values) to answer the same question.

For Example: **What is Life?**

Science values an objective and repeatable answer – this leads us a biological response in MRS NERG and an account that applies to all living things

Theology (RS) values answers that refer to purpose and meaning – this (along with other humanities responses) provides a much more diverse response that looks at meaning, creation, values, relationships etc.

Both science and theology are able to inform our thinking about this question with their norms of thought providing different disciplinary perspectives.

I can think like a scholar when I can...

- give an example of two disciplines that have similar preferred methods
- explain how a multidisciplinary approach to questions can be helpful

Bridging questions can also be used to compare how different disciplines interpret the same question (which may include breaking it down in to smaller questions for each discipline).

For Example: **Why did the Titanic Sink?**

Science answers the smaller question "what **caused** the Titanic to sink?" The answer focuses on questions about materials, floating and sinking, density etc. These can all be investigated through experiments using observations.

History answers the smaller question "who was to **blame** for the Titanic sinking?" The answer focuses on the roles of different people on board the Titanic but can also include those who were building the ship etc. These are investigated by looking at a range of sources and thinking about the bias' and purpose of diary entries, newspaper reports etc.

This approach helps students explore the preferred questions and methods of different disciplines. The table below compares science and history for "Why did the Titanic sink?"

	SCIENCE	HISTORY
Preferred questions	Asks questions which investigate the nature of the world around us e.g. What caused the titanic to sink?	Asks questions about people and events from the past e.g. Who was to blame for the Titanic sinking?
Methods	Investigate through observation. Undertake measurements to test a hypothesis. Seek repeatability where possible	Investigate through examining sources (physical objects or written, audio or video accounts) Select and organise relevant information from a range of sources Seek an accurate account as far as possible (this is harder the further back we go)
Norms of thought	There is a consensus about the results Results allow us to make accurate predictions about the behaviour of objects in the natural world. Results are objective	Different sources need to be checked for bias and motive. Results allow us to understand what happened in the past and may inform our thinking about events in the present/future Results are subject to interpretation
Note: This is not an exhaustive list, the aim is not to capture everything that is distinctive or similar between disciplines but to capture how students can recognise (without looking at the timetable/ title of the book) the kind of scholarly thinking they will be expecting to undertake.		

ACTIVITY 4: DISCIPLINARY APPROACHES TO THE SAME QUESTION

Why do we have rainbows?

Look at the two ways in which bridging questions can be used.

Think about how you could use this bridging question to explore either the norms of thought or preferred questions and methods for two disciplines.

You may want to consider what this would look like in class, and what initial responses you might get from your students before you introduce the disciplinary lenses.

The discipline wheel (p.57-58) and bubble tool (p.56) might be useful to inform your thinking.

ACTIVITY 4: REFLECTION

Which approach did you use to the question?

Different norms of thought:
Science leads us to an objective and repeatable answer focusing on light and refraction.
Theology leads us to an answer about meaning looking at God's promise to Noah

Different Questions / Different Methods
Art might ask a smaller question of "how can we make a rainbow?" or "what do rainbows symbolize?"
English might ask a smaller question of "how have we used rainbows in writing?"

When we need to break down the bigger question in to smaller questions for a discipline you often find that this doesn't provide a full answer. Because we have asked small questions that fit inside a discipline they often miss out some aspects, for example the smaller questions for English and Art don't include how rainbows are made or the idea of God's promise even though they look at other questions about rainbows as symbols.

Could other disciplines contribute to your answer?

Looking again what other disciplines could you use to answer this question? And which disciplines do you think your students would draw on? (How) would these responses change if the bridging question was "What do rainbows mean?".

Rather than providing the bridging question you could also start with the bubble tool and ask students to write down all their questions about rainbows thinking about how amenable they are to science. One of these questions could then be used as a bridging question, or two could be uses to explored how different disciplines might be best placed to answer them because of their preferred norms of thought.

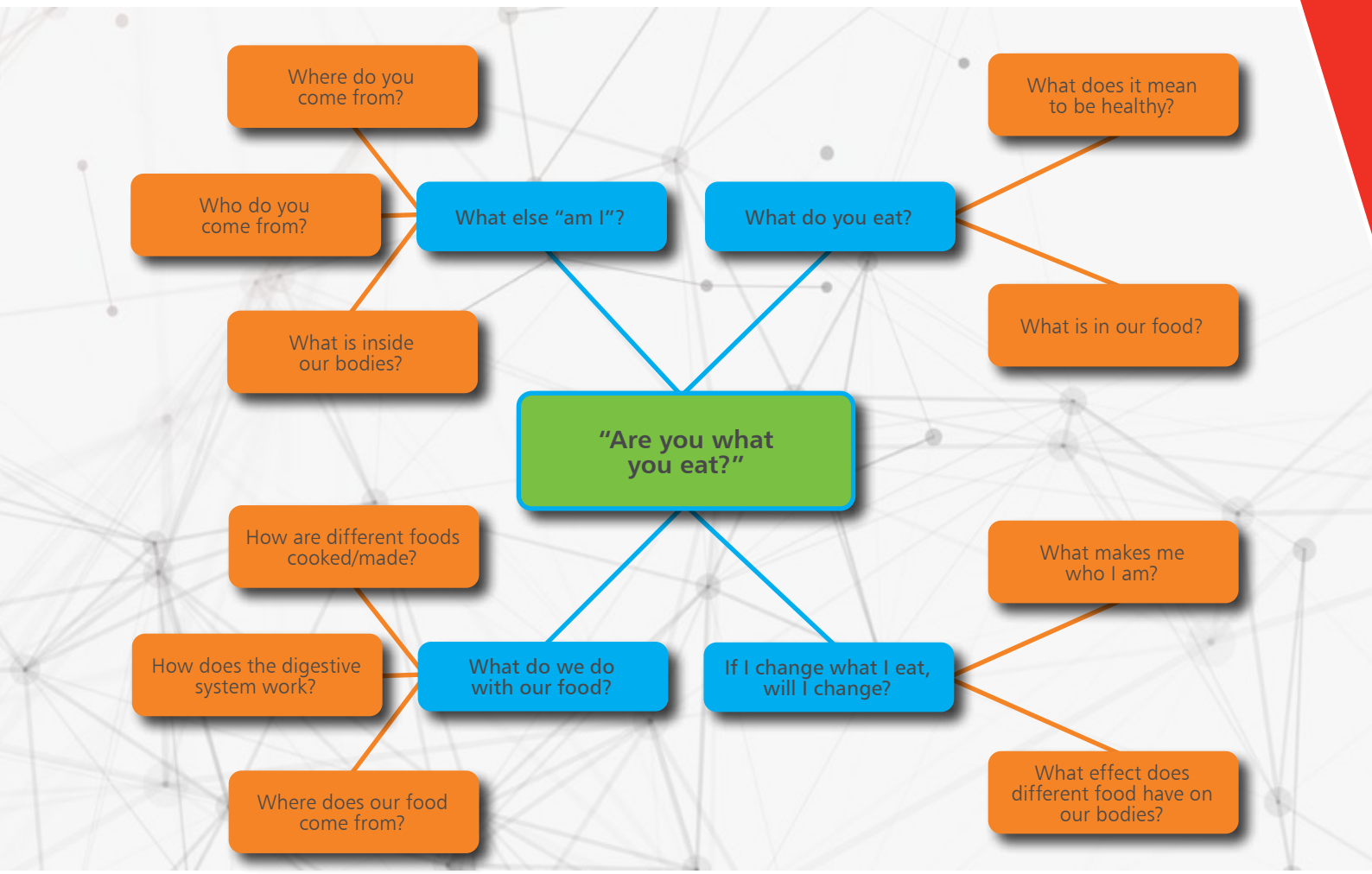
Thinking like a scholar

Looking at the thinking like a scholar poster on p.59 you can see that bridging questions can form a key role in supporting students to develop their epistemic insight and recognise the distinctiveness and interaction between different disciplines. This doesn't mean that all lessons need to be focused around bridging questions, but building the language of scholarly thinking into the wider learning can help overcome some of those challenges caused by subject compartmentalisation.

This does not mean you need to re-plan all the lessons, it can be as simple as introducing an opening question to your lessons, that prompts students to consider the different methods or norms of thought they will now be using. Alternatively you can highlight similarities to methods in a previous lesson e.g. textual analysis when moving from English to Religious Studies.

USING LEARNING WALLS

Learning walls provide an excellent opportunity for students to express their curiosity around a Big or Bridging question whilst also providing a visual reminder to students of the preferred questions, methods and norms of thought for different disciplines. The questions can then be explored in lessons (where they link to the curriculum) or during form time and other opportunities such as PSHCE.



Here questions are linked by smaller questions this means that the questions are re-compartmentalised in to their subject silos and allow further opportunities for students to explore the idea that "Science has some similarities and some differences with other ways of knowing". The central Big Question would sit on the largest bubble on the bubble tool as there are **smaller questions that science can answer.** The next layer of questions would sit in the middle bubble – each of these has at least one question that can answered by science and therefore is **partly amenable to science.** Finally, in the outer layer of questions there are questions that are **very amenable to science.** Within the classroom the three layers of the bubble tool could be identified on the learning wall with three different coloured stickers. This can be supported by conversation about what colour new questions should be.

Note that not all the "orange" questions can be answered within a single discipline, or by science, this isn't about creating a hierarchy of questions where science has "truth" and other disciplines have "opinion". They are defined by their preferred methods and norms of thought. Through this work students will be supported to recognise that Science begins with observations of the natural world and constructing ways to explain our observations, and that some methods are more scientific than others.

EPISTEMOLOGICAL ANALYSIS

Epistemological analysis activities are designed to improve students' critical thinking and understanding of how epistemic insight relates to real world-world problems. By considering disciplinary norms of thought and preferred questions (in particular) students' are supported to understand why disciplinary knowledge is needed in addition to substantive (content) knowledge when seeking real-world solutions to rich or "wicked" problems (those with multiple points to consider).

Start the lesson with a multidisciplinary (or bridging) question, such as "Can we see a painting by a historic artist in the way the artist intended?"

To answer this question students will need to draw on different norms of thought and methods from a range of disciplines (including art, history, and science).

They will also need to consider how to frame the question for their investigating discipline – for example by remembering that science deals with "small" (tightly defined) questions that exclude artist intent but include chemical make-up of the paint, and impact of different light sources on our ability to perceive a range of colours.

The investigation should consider what factors may mean that we are not currently seeing the painting as the artist intended:

- What conditions have changed?
- What impact has the passage of time had on the painting?
- What would we need to do to replicate the original viewing conditions?
- What can we presume about the artists' intentions (i.e. where they anticipated the painted to viewed, under what lighting conditions etc)?

A real-world example
When scientists working at the Chicago Institute of Art brought Renoir's Madame Léon Clapisson (1883) into the conservation studio and removed its frame, they noticed a thin band along the edge of the canvas where the red was much more vibrant than in the rest of the painting. Being exposed to daylight had faded one of the pigments used in the painting. Using spectroscopy, the conservationists identified the paint as cochineal red or carmine lake, which is made from crushed-up bugs.

How can viewers today see Renoir's painting in its original glory?

Beginning with a question raised by art
How can we help people to see Renoir's paintings looking the way they looked when he created them, before they faded? We are told that if the paintings are overpainted to replace the faded colours this is ethically undesirable because it can't be undone and artistically undesirable because it hides the authentic strokes of the painter.

Before colouring

Recoloured

Epistemological Analysis
What can analysis of the claims and knowledge in the problem and solution tell us?

There is a scientific claim and knowledge that the paint seems to be carmine lake, supported by electron spectroscopy and matching with the chemical signatures of paints. The chemical composition of the paint has direct observations to support it.

There's a claim that it would remove the authenticity of the painting if we paint over it to restore the colours. This seems to rest on an artistic (values) claim that the authenticity of the art is in the brushstrokes of the painter. To validate this we could ask art experts whether this is a shared value in art. This claim outside the methods of science to test using observations, but we can corroborate this claim about values in art in other ways.

There is a historical claim that it's Renoir who put the paint on the canvas. This can be supported by historical evidence such as letters, testimony, etc., but not direct observation (beyond science to verify) – this can support a conversation about how language (e.g. evidence) can mean different things depending on the norms of thought of the discipline using it.

In this instance science could inform our thinking by testing the age of the paint in the signature, perhaps. But we could also say that this is outside the scope of this problem as we are assuming this is Renoir's panting here, so there's also a boundary issue.

Related to the artistic claim there are also ethical judgements included in our response (i.e. the appropriate methods to achieve our aims). The ethical claim states that it is better to restore the visual look of the painting without doing something that is a permanent change to the painting.

Science can inform our decision if we do some experimentation to discover whether over-painting would be a permanent change. However, whilst science can inform our decision about whether overpainting would be permanent, it cannot tell us if it's good or bad to do so.

Related to this there is an aesthetic claim about overpainting hiding brushstrokes – at what point would such conservation/repair remove Renoir's hand from the painting. This could be tested in a quasi-scientific way by adding paint and asking people what they see. For example, we could say, once 50% of 100 people say they can't see brushstrokes, they're 'hidden'. It's quasi-scientific because the nature of the question requires us to look for the subjective experience, so we are getting this by asking people to say what they think they see.

The Real-World Solution

The Conservators at the Art Institute of Chicago created a digital restoration of the painting to show how it would have originally looked.

A "physical" solution may have been to bathe the painting in the appropriate wavelength of red light; however, this would have to be undertaken precisely to avoid adding colour to areas not affected by pigment loss. There is an accessible New York Times article on the project:
www.nytimes.com/2014/04/22/science/renoir-shows-his-true-colors.html

And by the art commentary site Hyperallergic:
https://hyperallergic.com/110385/the-chemistry-of-the-canvas-returning-the-red-to-a-renoir/

The Epistemological Verdict

The claim that we now see the painting looking like it originally did is not directly testable. There's a case to say that the 'restored' version is more like the original based on the colour boards, but to really test this we'd like to transport a group of observers to and fro in time to see both images. That might reveal a problem such as that in the past the light in the gallery was not the same as the light in a gallery today.

At this point we see that the original question has some ambiguity: Do I want to see the painting as Renoir saw it in his studio? Or as viewers saw it when displayed in a gallery? Or as I would see it in a gallery today? That points out that, if we change the goal a bit, it changes the answer we say is 'right'.

Science informed our thinking about lots of parts of this story, and within the bigger multifaceted issue, we can say that some questions are more amenable to science than others.

DISCIPLINE HATS

Discipline hats (whether physical or visual) act as excellent reminders when examining multiple disciplines in a single lesson. They not only provide a reminder of which discipline is being considered but also the disciplinary "kit bag" associated with it in terms of methods, questions, and norms of thought. Whilst every discipline has a different hat, items in the bag may be shared with different disciplines (especially in relation to methods and norms of thought). The kit bag can also be used to encourage students to sort methods, questions and norms of thought in order to recognise more easily many of the similarities between disciplines and not just focus on the differences. Particularly useful with Key Stage 3.

ACADEMIC POSTERS AND RESEARCH PROJECTS

Individually or in small groups students can produce academic posters. Academic posters contain a similar level of information to an extended GCSE-style answer but include wider skills such as basic referencing.

Academic posters may be a final output for a research project. To ensure posters or research projects build disciplinary as well as substantive (content) knowledge start students with the discipline wheel to establish the contributions different disciplines may make to a bridging question, or to frame smaller questions under a series of big (prompting) questions – for examples see the classroom toolkit on p.61-62.

Using the discipline wheel and/or the bubble tool with students as they plan responses will ensure they focus on methods, questions, and norms of thought rather than producing work that focuses solely on content. If multiple groups are researching the same question, they can be encouraged to compare the distinctiveness or similarities between the disciplinary approaches. Research projects support students to be independent learners and could contribute to nationally recognised qualifications.

SECTION 3
DEVELOPING AN EPISTEMICALLY INSIGHTFUL LESSON

BRINGING EPISTEMIC INSIGHT TO YOUR CLASSROOM

So far the focus has been on teaching and learning strategies, however this section will examine the practicalities of planning epistemically insightful learning experiences for your students.

We will take you through a worked example using the Big Question "What is a person?" This focuses on the "nature of Science in real-world contexts and multidisciplinary areas" and "relationship between science and religion". A similar approach can be used for bridging questions that don't include science - where students are examining "different ways of knowing and how they interact".

Within the Permeable Walls project there are opportunities to develop a range of learning opportunities for your students these include:

- A stand-alone lesson (that highlights the methods questions or norms of thought of that discipline, or the similarities/ differences between that discipline and another)
- A series of lessons using different disciplinary lenses (this could be embedded into form time/ transition lessons with year 7/ or be a collaboration across departments)
- A multidisciplinary project (extension/ homework/ extra curricula club or as above)
- Embedding epistemic insight language across your current teaching practice. (This builds on work with curriculum mapping, to highlight intent, methods and norms of thought – this could be as simple as using the language of "disciplines" or perspectives "informing our thinking")

Working across departments enables students to develop their understanding of disciplinary methods and questions that can better inform their career and education choices. Highlighting the interdisciplinarity of the real-world contexts for curriculum content can support students to maintain engagement with subjects they may otherwise think are "not relevant".

In all of these opportunities there is a focus on highlighting the distinctiveness of different disciplines and how they interact with other disciplines. This includes highlighting where disciplines are similar to each other. Developing students' epistemic insight includes supporting them to develop their understanding of methods within disciplines and how to frame questions for a specific discipline. This supports the development of their critical and higher-level thinking skills. We work with schools as co-researchers to understand how this can work in your setting what follows are suggestions and the example 5-minute lesson plan (on pp. 38-39 will be used to guide the process.

THE PLANNING PROCESS CONSISTS OF 3 STEPS

1

Building on current practice

This includes the design of the Big or Bridging Questions, looking at content links across the curriculum, and how this maps on to current delivery opportunities.

2

Developing students' epistemic insight

This asks you to consider how students will be supported to answer the three key questions of:

- **How does my/this discipline understand the question?** (Questions)
- **How does my/this discipline investigate the question?** (Methods)
- **How would my/this discipline know it has a good answer?** (Norms of Thought)

This ensures that students are developing their understanding of both disciplinary knowledge (knowledge about disciplines) and substantive knowledge (knowledge produced by a discipline). This avoids the risk of students only "seeing" the topic and not the disciplines.

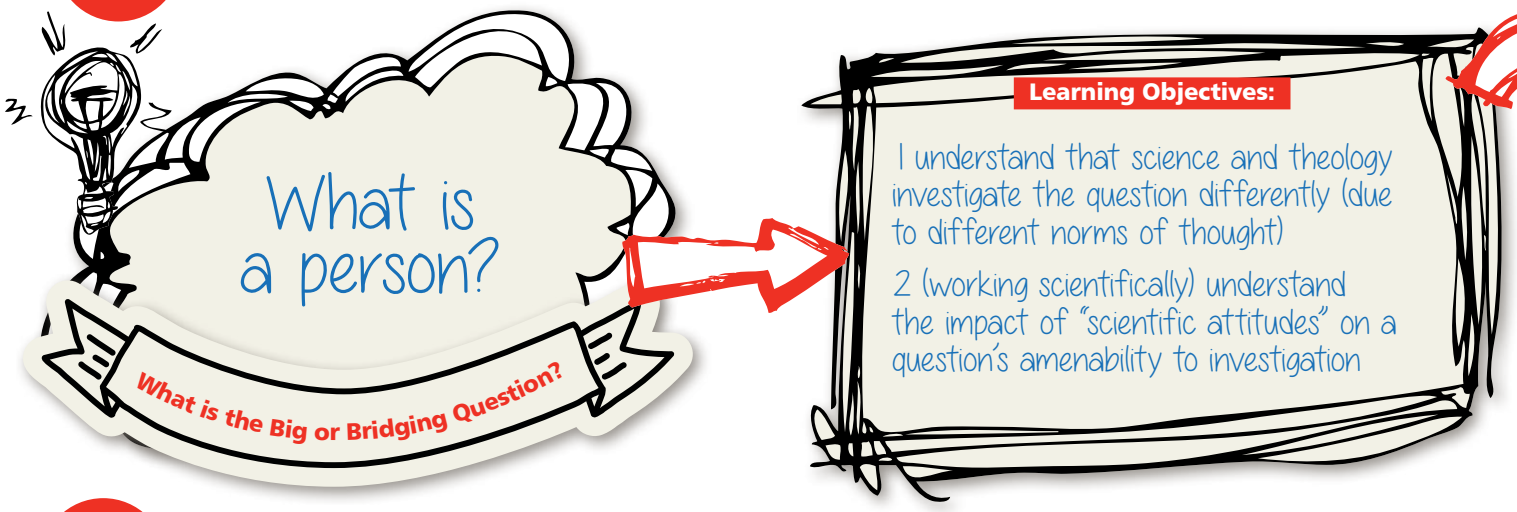
3

Building permeable "classroom" (lesson) walls to make links across the curriculum

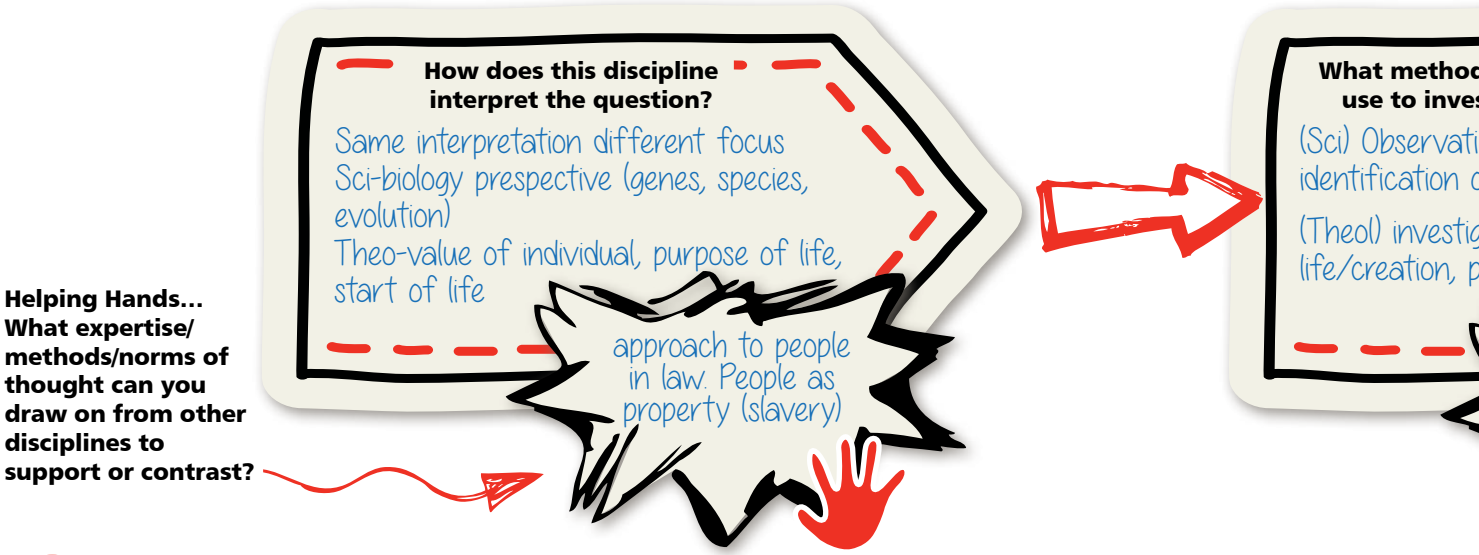
This includes thinking about the wider misperceptions that can be addressed (such the idea that science can answer every question – uncritical scientism), or if this is being designed to address a particular boundary (such as the one between science and religion). Finally thinking about how the epistemic insight and learning can be embedded by delivery in multiple lessons, or through bridging two disciplines in a single lesson etc.

5 minute lesson plan - bridging subject boundaries

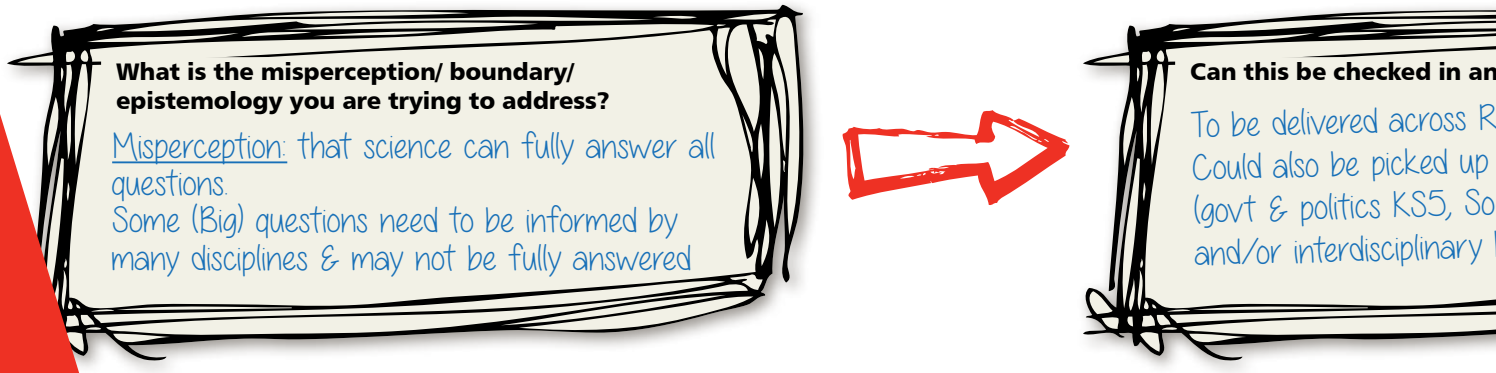
1 Building on Current Practice

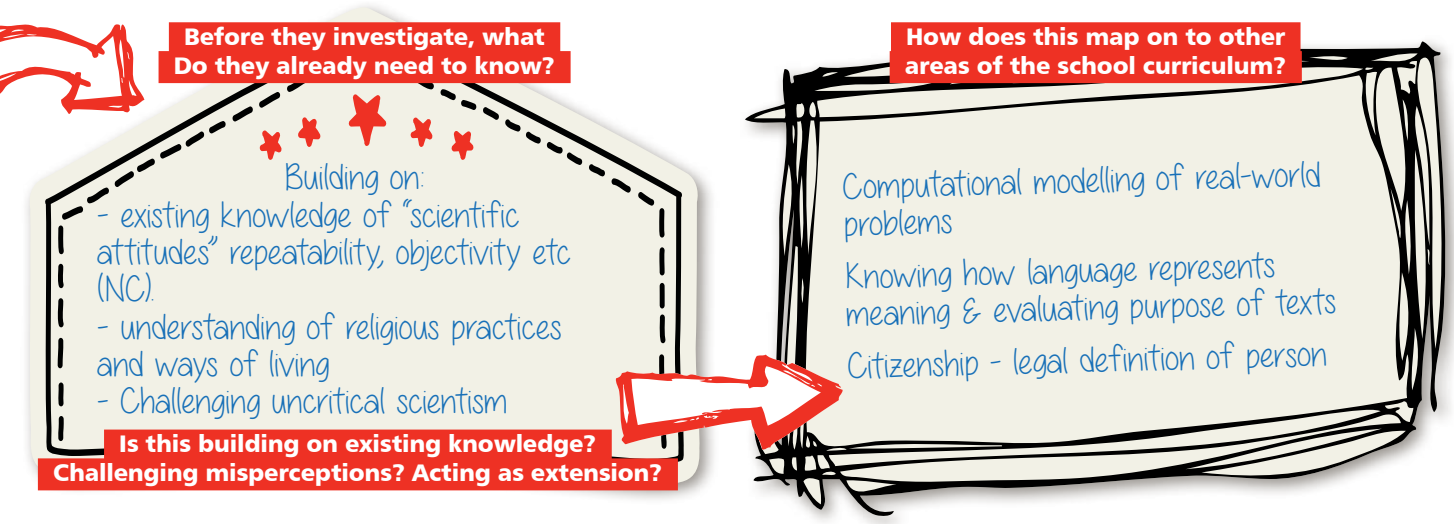


2 Developing Epistemic Insight: How can the students be s

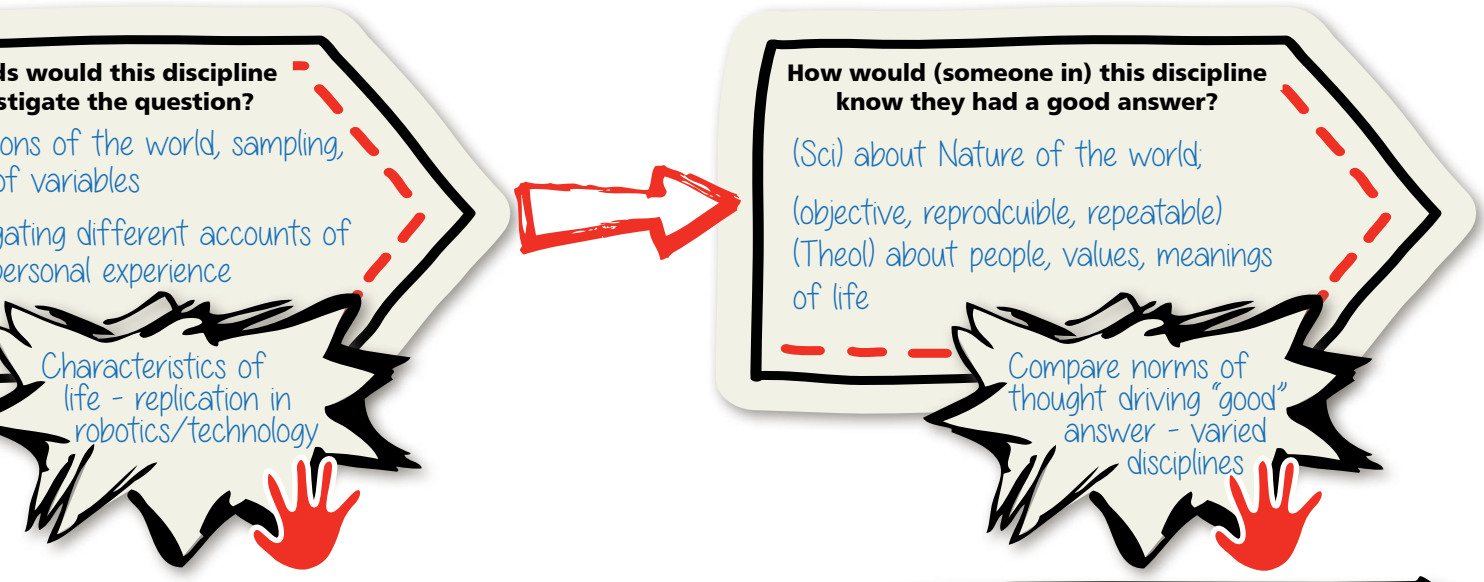


3 Building Permeable Classroom Walls: Forming links acros

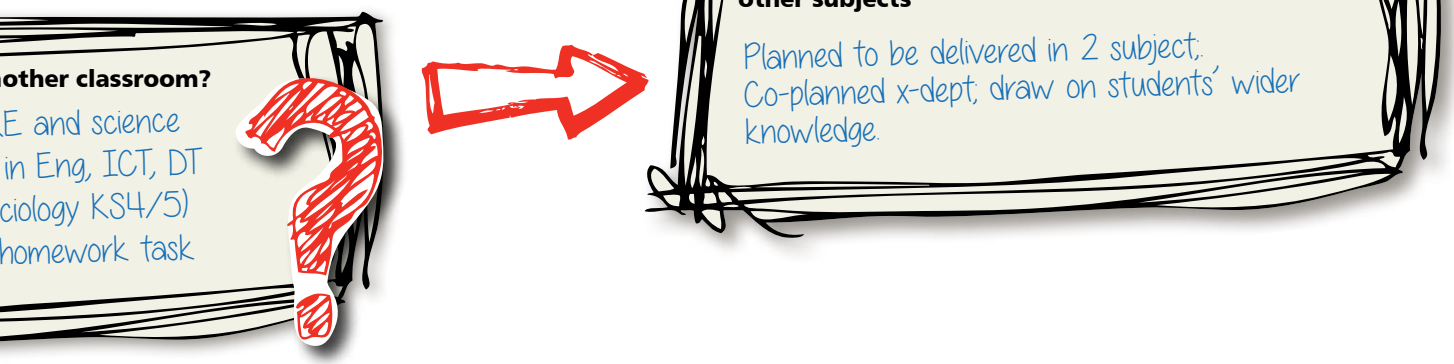




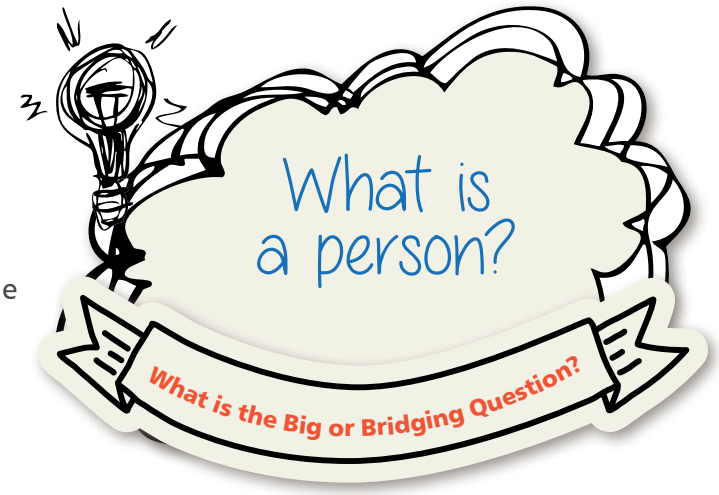
upported to answer these three questions?



s the curriculum



1 BUILDING ON CURRENT PRACTICE



Choosing whether to tackle a bridging or a big question is dependent on two things:

1. Is the session being delivered over only one or two lessons?
2. What are your learning objectives?

If a question is going to be examined over only one or two lessons, the best way to ensure that students are clear about the contributions each discipline makes is to focus on a tightly defined bridging question that is either able to show how different disciplines interpret or investigate the question (preferred questions and methods) or how they apply different values to answer the same question.

Here we are using a Big Question "what is a person?" to examine how the methods and norms of thought within a discipline influence what makes a good" answer. As it is a Big Question where many disciplines are able to inform our thinking there are numerous opportunities to co-deliver, or co-plan across departments.

The focus of the two lessons are theology and science (biology in particular). This links to learning objectives about the impact of scientific norms of thought (called scientific attitudes in the National Curriculum) and the relationship between values and methods.

Deliver it differently: Series of Lessons or Multidisciplinary Project

Big Questions can be better suited to a longer time frame for investigation. The clear exploration in two lessons allows student to keep focus on the "main" disciplines. However, in a single lesson with so many disciplines able to inform our thinking it can feel like a topic where everyone has something to say. When this is being examined over a greater number of sessions it is possible to dedicate sessions or groups to exploring particular disciplinary lenses to the question that can then be brought in to comparison and contrast.

Learning Objectives:

I understand that science and theology investigate the question differently (due to different norms of thought)

2 (working scientifically) understand the impact of "scientific attitudes" on a question's amenability to investigation

The Framework statements (and the corresponding "Being Epistemically Insightful" statements) are all drawn from the National Curriculum. Therefore, these may form a focus of your lesson(s) as is the case for this session. Equally "Being Epistemically Insightful" may be embedded within your classroom practice, particularly if your work on the project involves a transition series or whole school approach. When using content- focused LOs it is crucial that the differentiation of methods, questions and norms of thought for the different disciplines is explicit so that students are clear on the contribution each discipline makes to the response(s).

Note: within the LOs the methods ("investigate the question") and norms of thought have been combined. This is fine from a planning perspective. But make sure that students recognise that the norms of thought are about what is required to arrive at a "good" answer or one that is appropriate to the discipline. E.g. science isn't looking for an answer that addresses the meaning of life. In some instances, such as with science – the methods are designed in response to the norms of thought and therefore it is important students are clear on the distinction (and interaction of the two).

Links to wider curriculum: The LOs focus on the disciplinary and substantive (content) knowledge associated with the two disciplines the lesson is being delivered in. However, there is huge scope for students to draw on knowledge from other disciplines in examining the power and limitations of science and theology to respond to the question. This should be actively encouraged as part of their evaluation and in any associated project or essay work.

I can think like a scholar when I can...

- explain science and theology have different preferred methods and norms of thought
- give an example of how science can inform my thinking about a Big Question

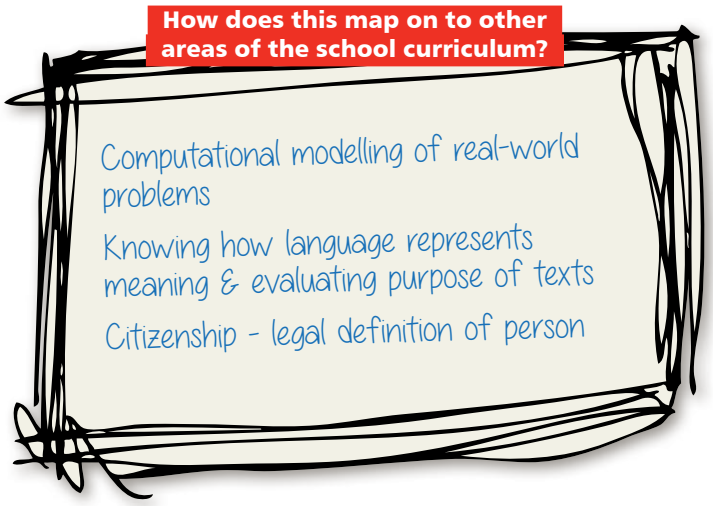
This section asks you to think about both the content knowledge that they need to engage with the bridging questions, and the wider epistemic knowledge and skills they need to engage. This may include information attached to cultural capital etc. For example, whilst students may be aware of the book or film "My Sister's Keeper" they may not be aware how the law changed regarding saviour siblings. In this example the lesson equips students with the knowledge and language associated with the two disciplines.

These examples are taken from a Key Stage 4 session that examines the role of reductionism in scientific method, its strengths, and impact it has on the kinds of questions that are amenable to science and the answers received.

The point is not to challenge scientism but to ensure that students are holding this view having critically considered whether science is providing a "full" answer. This is highlighted by the contrasting norms of thought associated with Polkinghorne and Crick's approaches to scientific explanation.

USING THE TOOLKIT

The discipline wheel or bubble tool can be used as a starter to assess the extent to which they think this is a multidisciplinary question and/or amenable to science.



In this instance where the question being examined is a 'Big Question', the curriculum mapping focuses on other disciplines that could be included in students' discussion, or where further multidisciplinary perspectives could be considered. Where you are planning to work with bridging questions you may find that the links pick up additional National Curriculum objectives that are being addressed alongside the epistemic insight LOs.

For example, whilst not examined in this plan, artificial intelligence (and the strengths/limitations of programming) can be used to examine the question whether MRS GREN could be seen in non-living robots. Additionally, linking to the citizenship curriculum and legal systems, there is opportunity to examine the adequacy of the EU legislative discussion that once robots are autonomous (enough) and can be held responsible for their actions they may be considered "electronic persons".

> 'MEPs have voted to propose granting legal status to robots, categorising them as "electronic persons" and warning that new legislation is needed to focus on **how the machines can be held responsible** for their "acts or omissions".'
> (Independent 14/01/17)

The link between language and technology offers an opportunity to examine when, where and why we use anthropomorphic language about technology. All these headlines attach intent to the actions of the robot, which implies intent and autonomy are important aspects of personhood – these are also valued in a theological response to the question but are more problematic for a scientific response.

Interdisciplinary examination of the issue allows students to develop their knowledge of key terms within a discipline and compare the use of the terms across disciplines where it is informed by methods, and norms of thought.

Deliver it Differently: Simultaneous Curriculum Content Delivery

This example shows how the question could be tackled across two discrete lessons that have been co-planned to enable links to be made to each other's lessons. Shared Curriculum content e.g. saviour siblings (gene technology/ therapy) in religious studies and science alongside contemporary representations in "My Sister's Keeper" could allow for students to study the content concurrently across disciplines as part of the existing curriculum, where key language of methods, questions and norms of thought highlights the distinctive contribution each discipline makes.

Things to Think About

The Saviour Siblings case provides an excellent example for students where the law changed not due to a change in the power or limitations of science, but due to a change in our attitude to the value of people.

Thinking about the norms of thought associated with different disciplines supports students to engage with the curriculum objectives to understand the nature, processes and methods of science so that they can answer scientific questions about the world around them.

In relation to Saviour Siblings consider the following questions:

What (if any) are the similarities or differences in the evidence? Is the evidence acceptable because of the methods used?

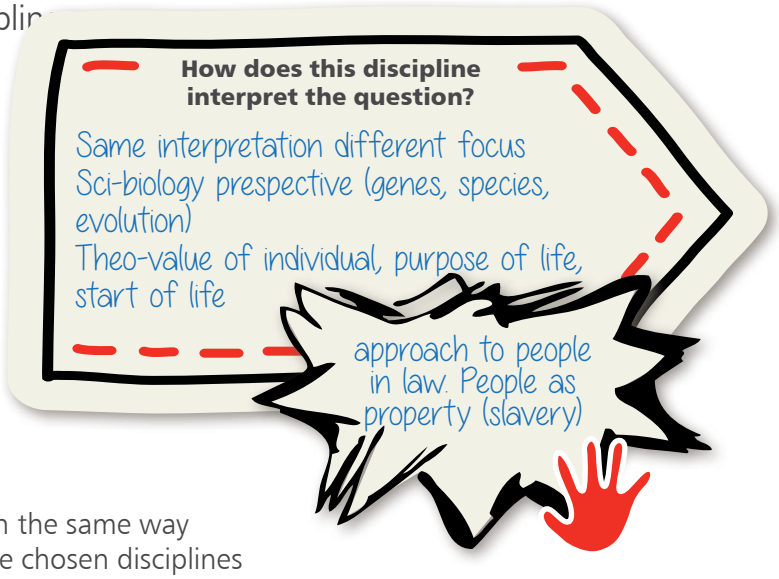
Does the evidence provide a good answer? How could the answer be improved? (limitations)

How amenable to science are these questions?

Thinking about the preferred methods and norms of thought also supports students to challenge the disciplinary use of language, and how due to the norms of thought (values) of different disciplines, this means that shared language is applied and interpreted differently because of what is valued. E.g. A personal testimony from a saviour sibling wouldn't be evidence in science but it's excellent evidence in theology or politics.

2 DEVELOPING EPISTEMIC INSIGHT

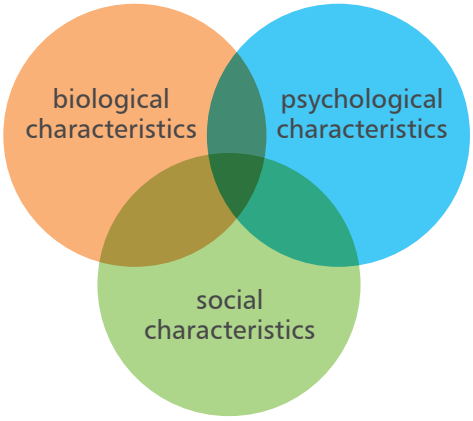
Even where the LOs are content driven it is fundamental that students leave the lesson(s) able to answer at least one of these questions (framed age appropriately). As designed the two lessons support students to answer all three. However, you may choose to focus on one or two within a single lesson, to ensure that they have the higher level thinking necessary to recognise knowledge formation within a discipline and the relationships between disciplin



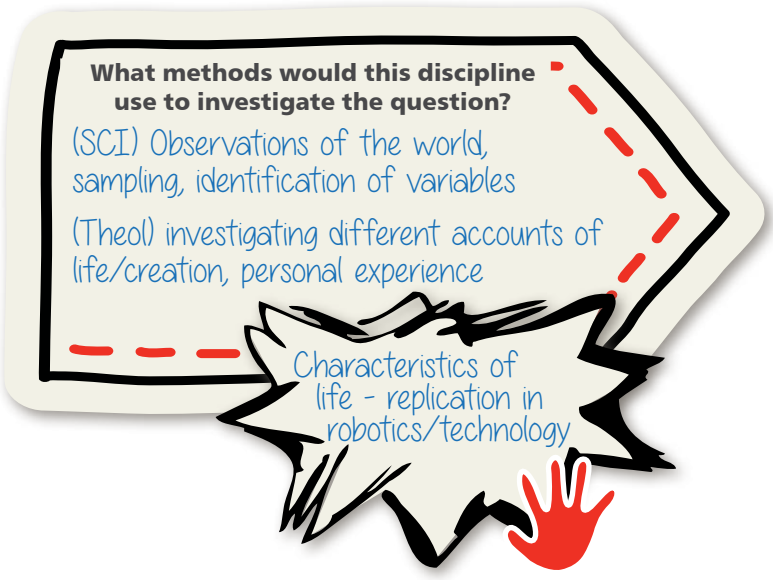
As observed earlier not all big or bridging questions will be interpreted differently by different disciplines. The "interpretation" can be understood as asking if the questions needs to be reworded to make the *implicit* preferred questions and norms of thought *explicit*. This is done by framing the bridging question in to smaller questions (where necessary) that are very amenable to the disciplines in discussion.

Where disciplines interpret the question in the same way (such as here) the norms of thought of the chosen disciplines (and others) take on greater significance to inform our response.

An excellent place to start with this question in the religious studies classroom is to ask students to consider what makes them who they are. Once they have completed the initial "jelly person", as a class, sort the characteristics into the Venn Diagram – this simple activity starts to highlight the complexity of placing characteristics like personality; can start to highlight the distinctive contribution science (biology) makes, and encourage examination of the norms of thought within theology that are concerned about a different approach to personhood.



At Key Stage 5 this links with philosophy of mind modules for A-Level and Pre-U.



Across the two lessons the relationship between the methods and norms of thought within each discipline are important to highlight, as what is taken as evidence, or considered important within the definition is influence by the methods each discipline uses to investigate the question.

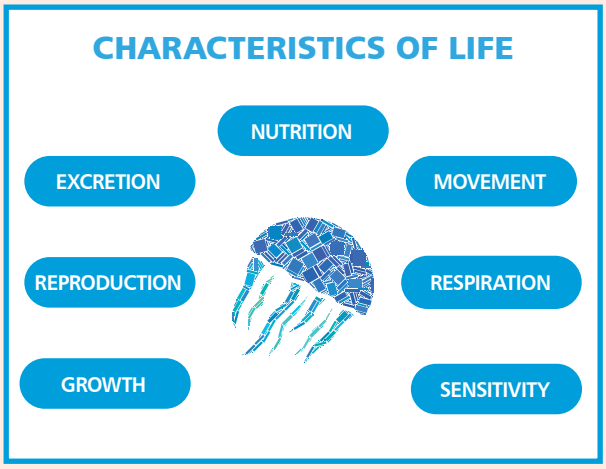
The use of theology as the contrasting discipline is used to challenge uncritical scientism (that science is able to fully answer all questions) and to introduce students to limitations of some experimental results when placed in less controlled real-world contexts.

SCIENTIFIC METHOD

Begin with a recap of MRS GREN and the characteristics of life.

Highlight to students the importance of the objectivity and repeatability of this account and consider the challenges arising from an account of "life" that is applicable across species.

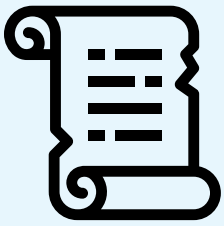
Having established the definition of life applies to all species – ask students to consider how the scientific method (including observation) can provide a description of a "person" that can accommodate the vast variety of individuals. If taking place after the religious studies lesson students can be prompted to consider the biological characteristics they identified in the previous lesson.



Students are then asked to frame questions that would be amenable to scientific investigation that deal with "what is a person?" Depending on the chosen focus this may include:

- A focus on genetic variation between individuals within a species (KS3).
- A focus how the interaction between genomes and the environment influence phenotypes/classification of species and developments in biology (KS4)

Do students feel that the biological account provides a full account of human personhood or are there limitations to answer science provides?



THEOLOGICAL METHOD

One of the challenges of introducing students to the discipline of theology (over the curriculum subject of religious studies) is helping them to understand the associated methods. The humanities often fall in sharp contrast to sciences where most students have a least a basic understanding of "working scientifically". There are numerous parallels between the methods of history and theology, and this can offer a good starting place. For students to consider the types of evidence or resources a theologian may examine. (The reverse challenge exists with norms of thought where these are more readily identified in theology and require further support to identify in science).

Having established the methods appropriate to theological enquiry the question of human personhood can be explored in a variety of ways:

- It may include comparing creation stories about the beginning of life – considering the purpose/intent of these religious accounts and/or what they say about what makes humans unique.
- It may include consideration of stewardship narratives, that highlight human purpose in relation to the world around them. For example the relationship between (theological) stewardship and (scientific) sustainability.
- Consideration of the impact of religious beliefs on ways of living e.g. is/should happiness be the purpose of human life.

Whilst there appears to be a clear link to questions on the "start of life" (e.g. conception) due to the potentially sensitive nature of these topics, and strong feelings that their discussion can generate, there is a risk that the epistemic insights around disciplinary knowledge become lost. Where epistemic insight is embedded within the curriculum however there is opportunity to highlight how legal, scientific and theological approaches to life (and death) are dependent on different norms of thought (and in some cases knowledge is restricted the kinds of methods available to the discipline).

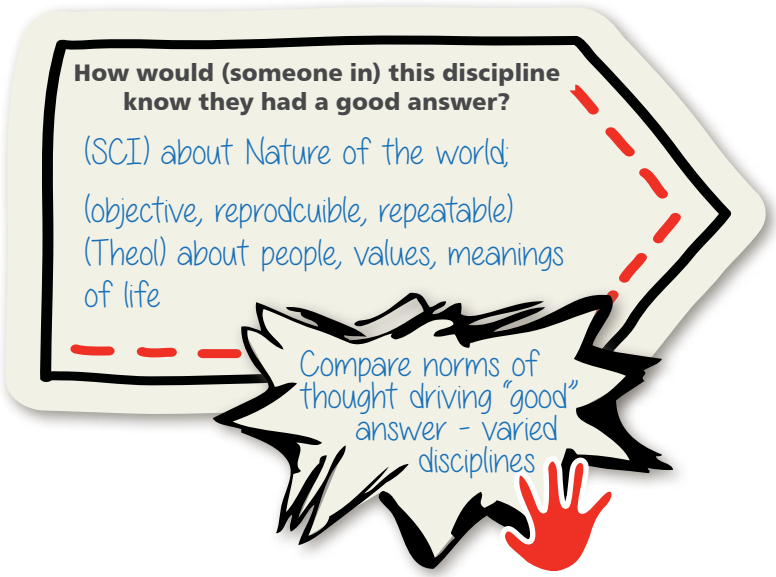
Highlight that theology doesn't provide a definitive answer to what a person is (i.e. how to know something is a person – that is the role of science), but instead provides information about how to live in the world and what makes life purposeful.

Deliver it Differently: A Lesson on Methods

Exploring different methods can form a lesson in isolation. In conjunction with the Discipline Wheel students could be asked to think about the different methods each discipline would use to investigate a question.

Combined with an adapted Bubble Tool, students could be asked to sort different methods to answer a single question, or more generally sort "different ways we find out about the world".

The different norms of thought are brought together during the plenary in each lesson, where students are asked to consider the power and limitations of the discipline's response to the question. Attention is drawn to the fact that the answers in the science lesson focused on observations of the world. They arrived at answers that were reproducible and objective.



The responses from the religious studies lesson focused on the question of purpose, finding greater meaning in life and about our relationships to each other and the world. These are good responses for theology, but do not provide the measurable definition required by science.

Because ultimately this is a Big Question there are a lot of things that potentially remain unanswered, however both disciplines are able to **inform our thinking** about what human personhood is. Both disciplines miss aspects that many people would find important and this is still true when we bring in, or explore the issues raised by the "helping hands" on the planning document.

If tackling the associated question of saviour siblings (or using this to explore personhood with older students), much of the foregoing discussion will still apply – particularly in relation to the impact that norms of thought have on developing answer to the question "should science be used to create saviour siblings?" For further information and resources on co-teaching and/or co-planning a science and religion session on saviour siblings email **lasar@canterbury.ac.uk**

USING THE TOOLKIT

The discipline wheel can be used to support students to think about the norms of thought (values) that help them to know they arrived at a "good" answer. It can also be used to encourage students to think about which other disciplinary perspectives may add to our understanding. For example what do English or the arts add to our understanding of who we are?

ACTIVITY 5
BRIDGING QUESTION FOR SCIENCE AND HISTORY

Having now seen a worked example for science and theology, think for yourself (or as a group) what a similar two lessons might look like for this bridging question on the great fire of London. Use the table below to think about how the spread of the fire due to close buildings and the materials used could be modelled in a practical activity.

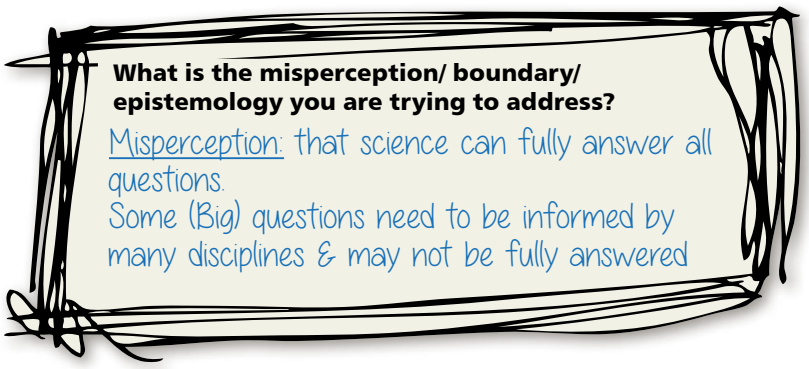
Bridging Question: Why did the fire of London spread so quickly?			
Being a science scholar		Being a history scholar	
Preferred question:		Preferred question:	
Informed by: Practical science experiment		Informed by: Investigation of the events and people	
Methods	Norms of thought	Methods	Norms of thought

I can think like a scholar when I can...

- explain how different disciplines investigate a question
- illustrate how another discipline is diferent to science

3 BUILDING PERMEABLE CLASSROOM WALLS

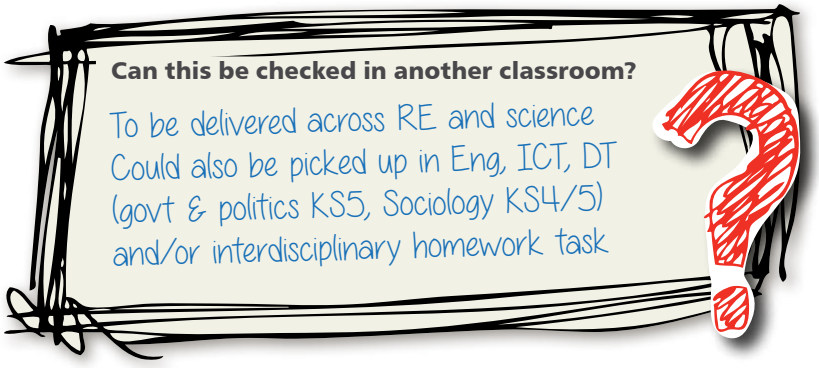
The final section of the lesson plan addresses the issues of how the session is embedded within the wider work and addresses the development of students' epistemic insight as well as their content (substantive) knowledge.



Not every lesson will be addressing a boundary or misperception, but they should always be developing students' understanding of how knowledge is formed within a discipline (and the interaction between disciplines).

Here the epistemic focus is on the nature of questioning:

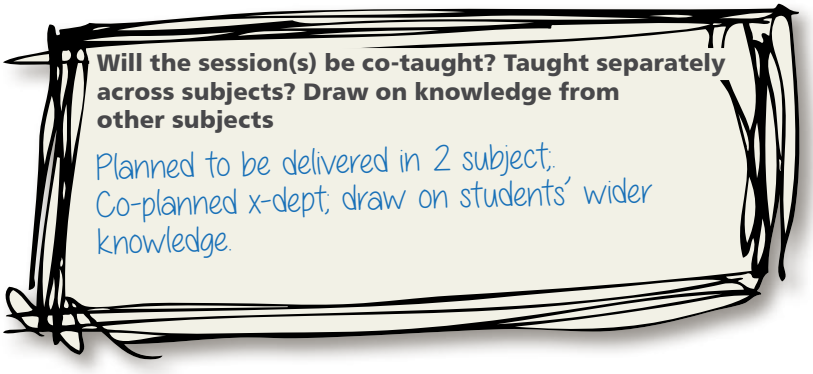
- Relating to the Bubble Tool – that there are often smaller questions that are amenable to science, but that does not mean that every question is amenable to science.
- Relating to preferred questions – science specifically addresses the formulation of appropriate questions, to be able to do this, students need to understand what makes a question amenable to a particular discipline.
- Relating to norms of thought – this is often implicit in religious studies agreed syllabi in relation to themes of "Religious practices and ways of living; questions about values and commitments"



We often check learning in a different lesson (or classroom) in this example the learning would be delivered across two lessons so there is a natural space to make direct comparisons to the methods and norms of thought addressed in the other lesson.

If being delivered in a single lesson, as a series of lessons or across an afternoon, visual reminders about the relationships may be helpful – for example using "disciplinary hats" when investigating within a discipline. This can support prompting of how students are thinking like a particular scholar, and the norms of thought that matter to a theologian are different to a scientist.

Alternatively, you may decide to broaden the task to include other disciplinary approaches either through synchronous teaching of linked content, or through research projects, joint planning or enrichment activities. Within the secondary and sixth form settings appreciation and understanding of disciplinary approaches can be included within debating or philosophy clubs and can support synoptic thinking about the inter-relationships between diverse disciplines. Finally, exploration of science and technology in real-world contexts highlights the relationship between science and the humanities that can support students to see continued relevance of science to their lived experience as they move through GCSEs and A-levels/BTECs.



Finally thinking about the delivery and whether there are opportunities for this to be co-taught or planned across departments as well as drawing on the wider knowledge of students from across their disciplines. This is particularly important when working with Key Stage 4 and 5 students where options will provide alternative disciplinary perspectives.

Lastly it may be that bridging or big questions are addressed in two different disciplines (history and geography) but students are encouraged to think about how the evidence, or investigation provides a different response to when they are "thinking like a scientist".

EPISTEMIC INSIGHT CLASSROOM TOOLKIT

5-MINUTE LESSON PLANNING TEMPLATE

This offers a quick 3 step process to begin planning an epistemically insightful learning experience. **1. Build on current practice** - curriculum content / students' understanding of methods and norms of thought and any curriculum mapping already undertaken.
2. Ask yourself & your students 3 key questions – these highlight the strengths & uniqueness of disciplines & help students to navigate the pedagogical engineering of subject division & curriculum content.
3. Helping students navigate the curriculum requires explicitly building links between disciplines and helping them understand the unique contributions disciplines can make to the same issue/question.

THE BUBBLE TOOL

The Epistemic Insight Bubble Tool provides a strong visual to highlight the powers and limitations science. Is science able to answer the question effectively or does it need other disciplines to inform it? Does the question need to be reframed to address part of, or an interpretation of the question scientifically? When examining Big Questions this can be used to consider how science may inform our thinking through organising smaller questions that are part of the Big Question.

DISCIPLINE WHEEL

By placing a big question in the middle of the discipline wheel, it can support students to think about how other disciplines might investigate the question, or how the question might need to be reframed to provide a smaller question for specific disciplines. Content links can be used as a strategy to start the conversation provided students are then invited to use these to consider the preferred methods, questions and norms of thought. The filled wheel can be used to prompt students thinking
or the blank wheel can be used to invite their thoughts on necessary disciplines. The filled wheel isn't an exhaustive list of disciplines but does offer examples.

THINKING LIKE A SCHOLAR

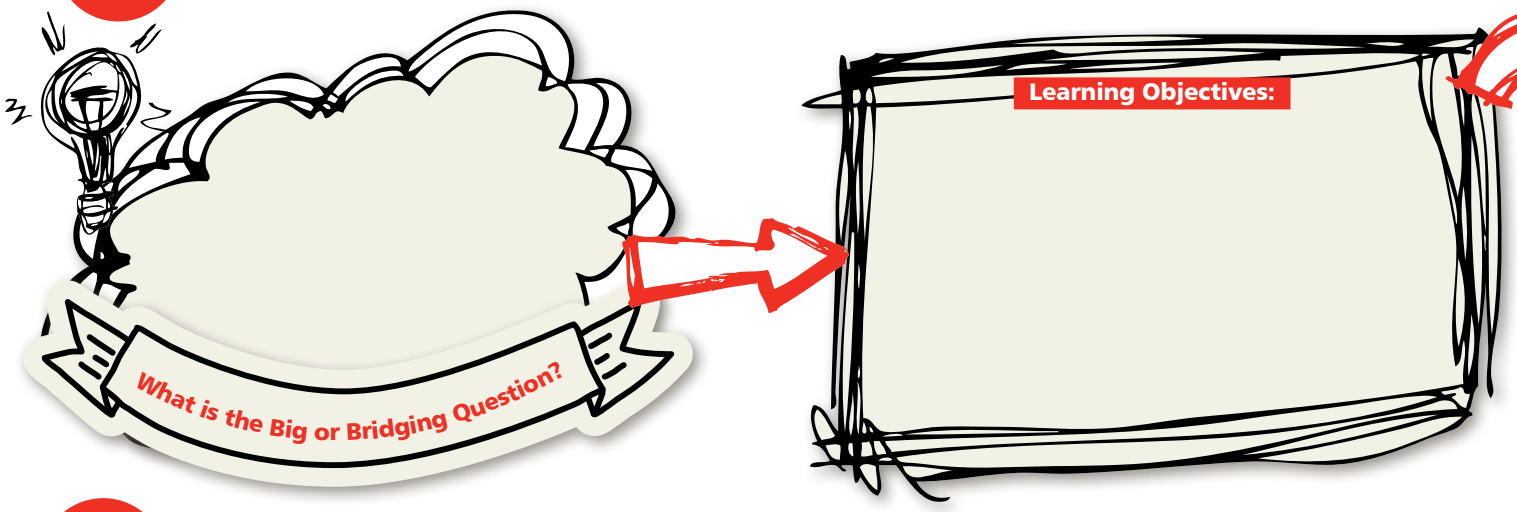
The poster highlights some good examples of what it means for a student to be epistemically insight by the end of Key Stage 4. For students in lower year groups showing epistemic insight can be as simple as being able to sort Big Questions (that need lots of disciplines) from small questions (that
For example, knowing that "Why is the World here?" is a different kind of question to "What makes leaves green?". Other classroom tools such as the bubble tool can be used to support students to sort questions and the language can be adapted where appropriate.

The classroom tools have been initially developed for use in Key Stage 3 and 4 in mainstream settings, they have also been used with post-16 students, if you would like to work with us to develop any of them to reflect SEN/EAL strategies please get in touch, we'd love to hear from you.

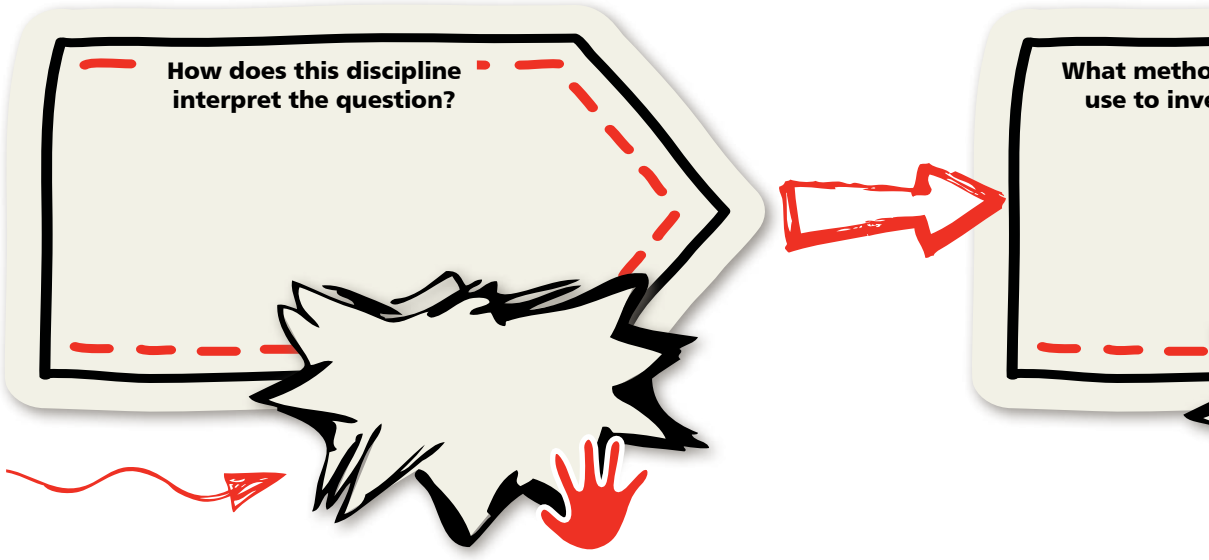
Epistemic Insight

5 minute lesso

1 Building on Current Practice

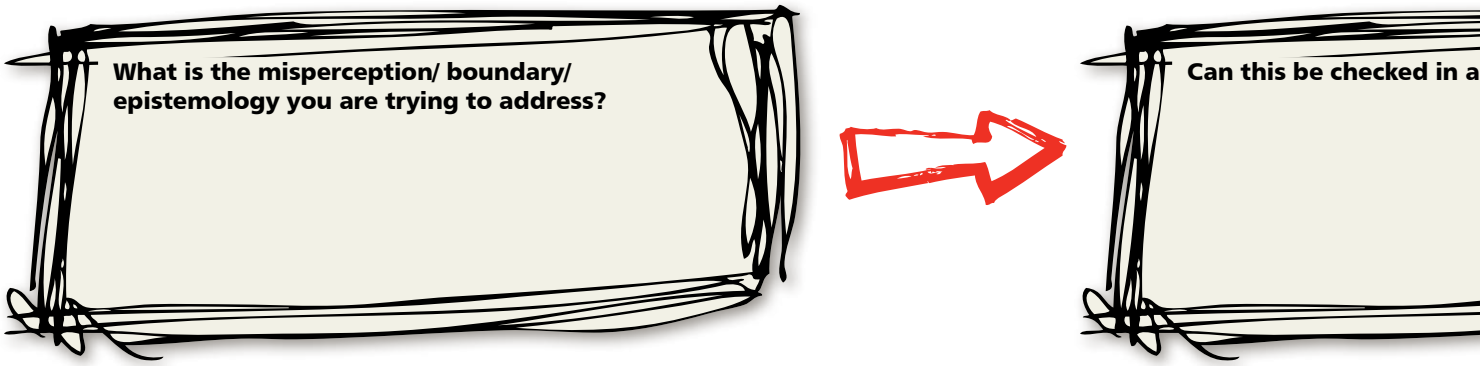


2 Developing Epistemic Insight: How can the students be s



Helping Hands... What expertise/ methods/norms of thought can you draw on from other disciplines to support or contrast?

3 Building Permeable Classroom Walls: Forming links acros



on plan – bridging subject boundaries

Before they investigate, what
Do they already need to know?

How does this map on to other
areas of the school curriculum?

Is this building on existing knowledge?
Challenging misperceptions? Acting as extension?

supported to answer these three questions?

ds would this discipline
stigate the question?

How would (someone in) this discipline
know they had a good answer?

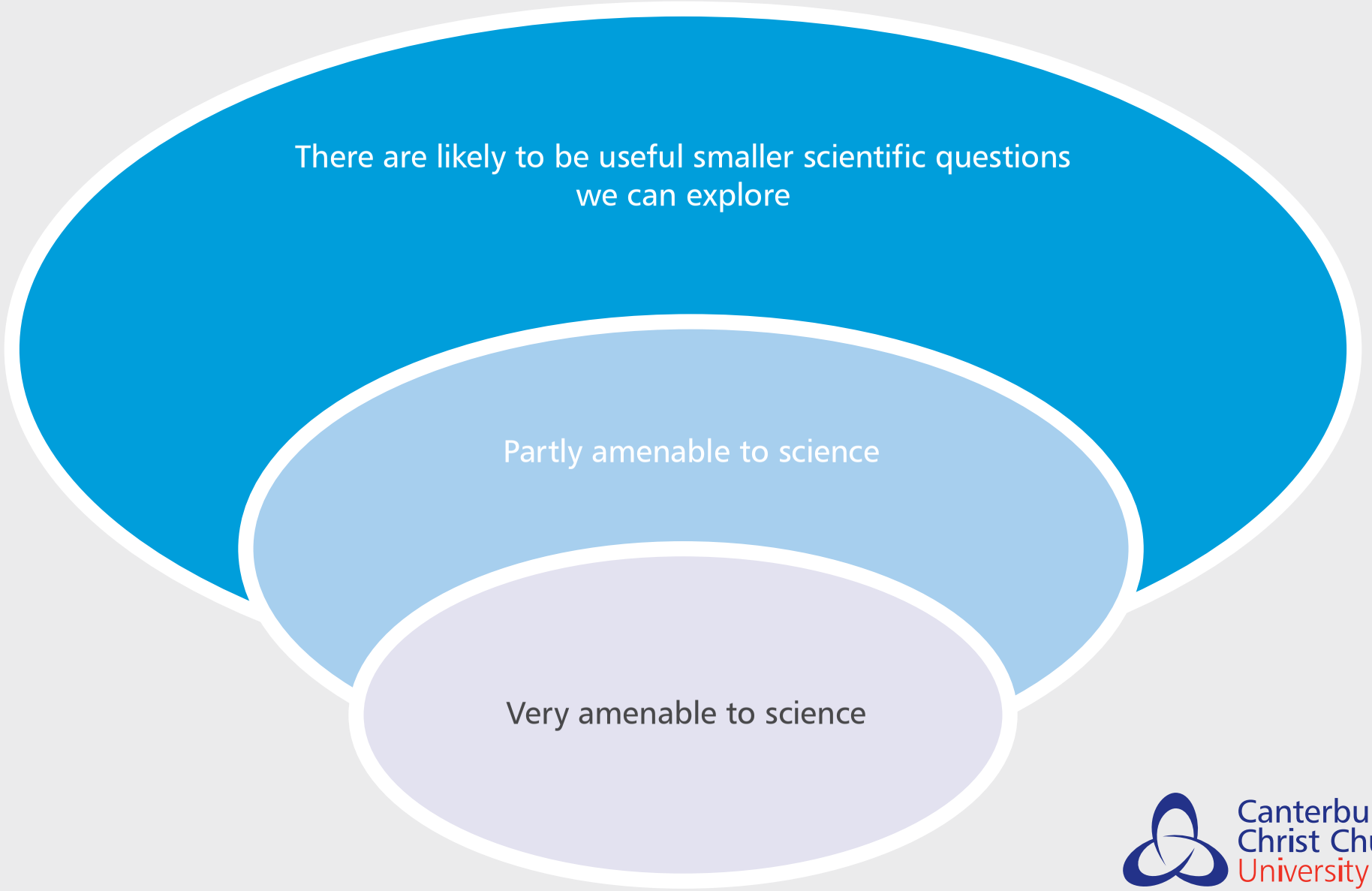
ss the curriculum

other classroom?

Will the session(s) be co-taught? Taught separately
across subjects? Draw on knowledge from
other subjects

Canterbury
Christ Church
University

Epistemic Insight

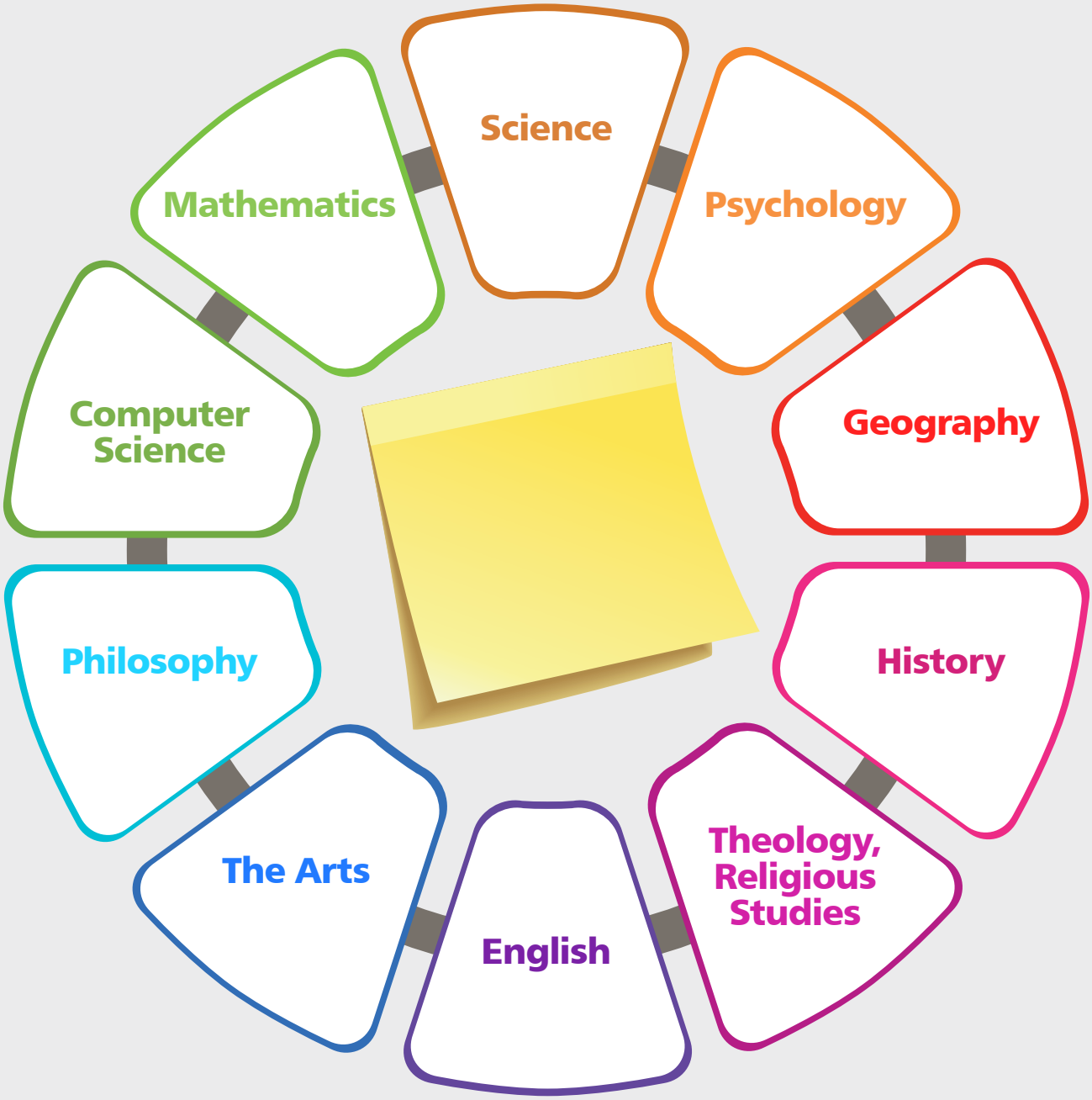


Canterbury Christ Church University

Epistemic Insight

The Discipline Wheel

Put a question in the middle



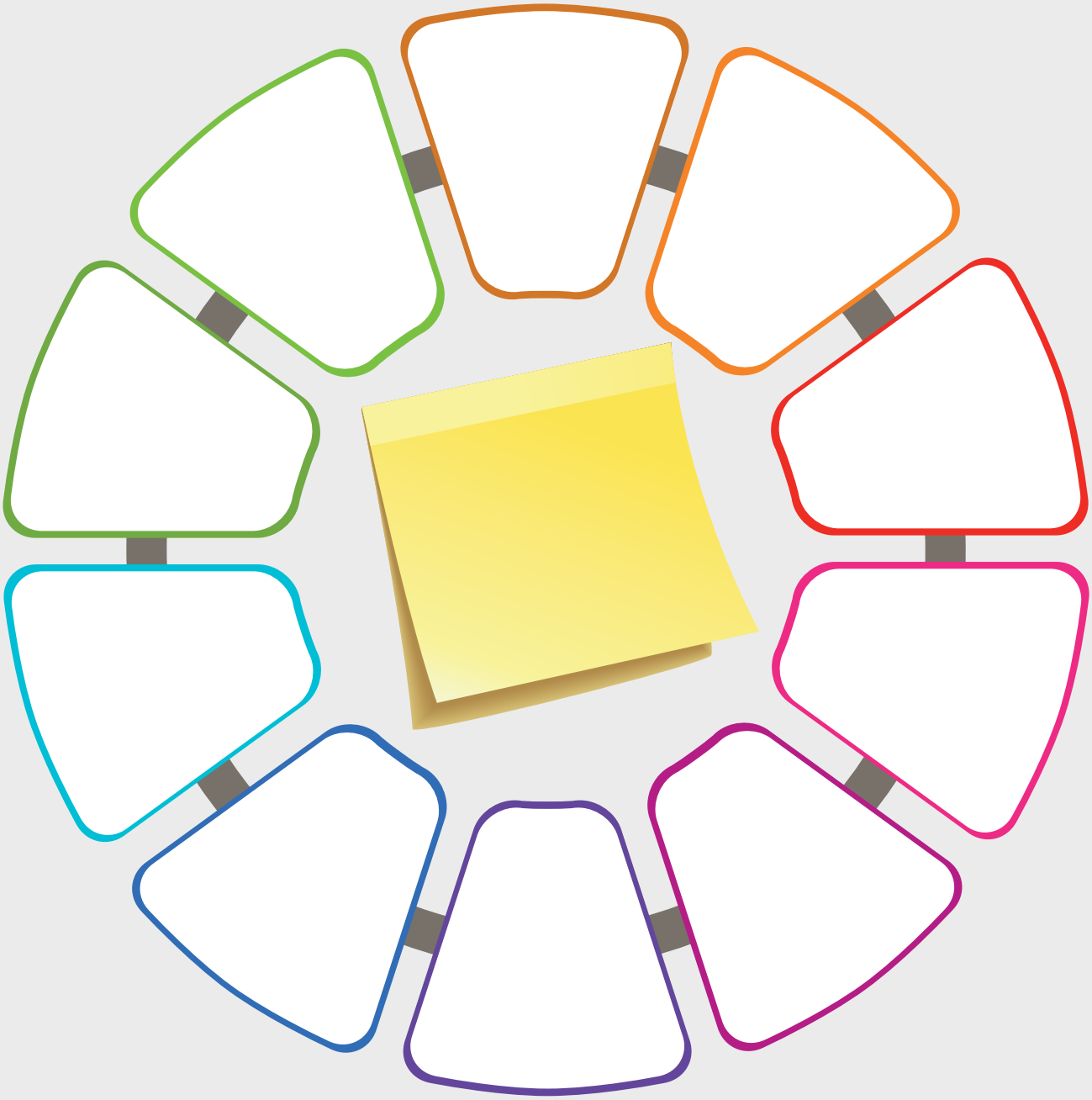
- **Which disciplines can inform your thinking about the big or bridging question?**
- **How would the discipline(s) you have chosen:**
  - Interpret the question?
  - Investigate the question?
  - Know they have arrived at a good answer?

Canterbury Christ Church University

Epistemic Insight

The Discipline Wheel

Put a question in the middle



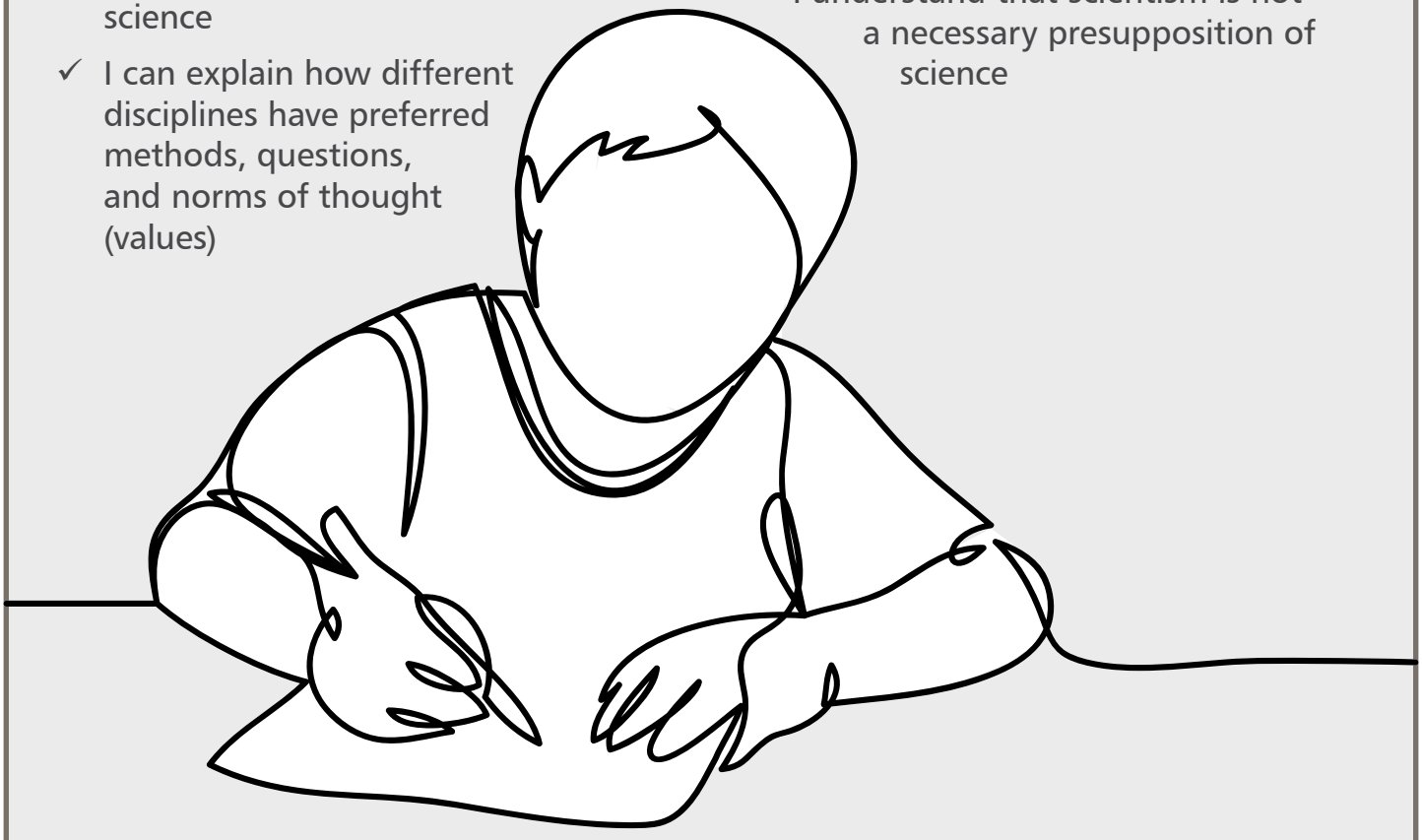
- **Which disciplines can inform your thinking about the big or bridging question?**
- **How would the discipline(s) you have chosen:**
  - Interpret the question?
  - Investigate the question?
  - Know they have arrived at a good answer?

Canterbury Christ Church University

Epistemic Insight

I am "Being epistemically insightful when…"?

- ✓ I can sort questions in to different disciplines.
- ✓ I can explain what makes a question amenable to scientific enquiry
- ✓ I can sort questions than can be answered in one discipline [like science] from questions that need a multi-disciplinary response [e.g. informed by science and history]
- ✓ I can explain how another discipline [like geography] is different to science
- ✓ I can explain how different disciplines have preferred methods, questions, and norms of thought (values)
- ✓ I can explain how a discipline's preferred methods may influence the answer it provides to a question
- ✓ I can explain how different disciplines help me to investigate a Big Question
- ✓ I understand that some questions are more metaphysically sensitive than others
- ✓ I understand that science and religion are not necessarily incompatible
- ✓ I understand that scientism is not a necessary presupposition of science



Remember in a discipline we ask/answer the same kinds of question and investigate questions in the same way.

1. How does this discipline understand the question?
2. How would this discipline investigate the question?
3. How would (someone in) this discipline know they had a "good" answer?

Canterbury Christ Church University

SAMPLE BRIDGING QUESTIONS FOR EPISTEMIC INSIGHT RESEARCH PROJECTS

The following examples are prompt questions that bridge science and at least one other discipline. These larger prompt questions encourage students to consider the methods, questions and norms of thought associated with the contributing disciplines. These could be used as a starting point for designing research projects or to support students to design their own bridging or multidisciplinary questions to research.

Multidisciplinary research projects could be used in preparation for, or submission as, Nationally recognised Level 2 Higher Project Qualifications (HPQ) or Level 3 Extended Project Qualifications (EPQ) – offered by a range of exam board in England and Wales.

Alternatively, each question has "smaller" questions that have been framed for scientific investigation and may be used to support the completion of a Bronze CREST award **www.crestawards.org**

INSPIRING MINDS

These and similar questions are examined as part of the Inspiring Minds programme run in collaboration with the Schools and College Engagement Team for more information, to check students' eligibility, or for online resources for students, email **kamcop@canterbury.ac.uk**

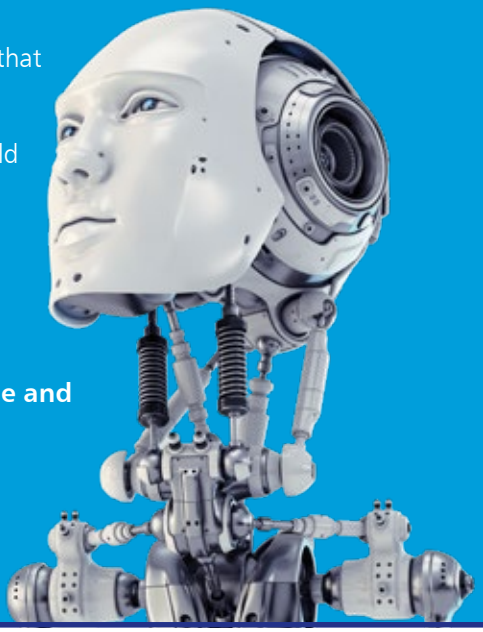
ROBOTS WILL ONE DAY BEHAVE JUST LIKE HUMANS

Background

In January 2017 members of the European Parliament voted to propose giving legal status to robots, defining them as "electronic persons" and warning that new laws are needed to focus on how the machines can be held responsible for their "acts or omissions".
This raises the question whether we are going to end up with a two tier system of robots and humans or whether eventually robots and humans will come under the same protection as both have "personhood".

HAVE YOU EVER WONDERED

… about the criteria we use to define life? Or what we mean when we say that we learn by interacting with our environment?
… Why viruses has caused such a debate about whether they are biological machines or living organisms? If viruses are so difficult to define, what would a robot need to be a (learning) life form not a machine?



Questions Framed for Scientific Investigation

- **Can a robot be considered a person?**
  - **What are the criteria we use to define life?**
  - **Is a virus the simplest form of life or an organic machine?**
  - **What criteria would you use to distinguish between machine and life form? Can you find parallels with a robot?**

Off-Piste…

- **Cyborg! Which organs can a human survive without, and which can currently be replaced by artificial equivalents?**

HUMAN-TECHNOLOGY INTERACTION AND OUR "OFFLINE" IDENTITY

Background

The internet is changing our lives, but is it also changing our sense of self and other people? We think of the "selfie" as something new but in fact it is nothing more than the latest way in which we can show other people how we would like to be seen. However what is new, is the way in which we increasing interact with technology in a self-defining way. This raises questions about how we are interacting with technology and whether technological advances are always technological improvements.

HAVE YOU EVER WONDERED

…How your social media gets from your phone to the internet? Or how the GPS in your phone actually works?
… Why some people still use cameras with film? Or how your camera phone works?

Questions Framed for Scientific Investigation

- **How does social media get distributed?**
  - **How do mobile phones "know" where you are?**
  - **How does the internet work?**
  - **Is a painting a truer representation than a photograph?**
  - **How are digital images made?**
  - **How does a printed image differ from a painted image?**

Off-Piste…

- **Is my data safe?… The different forms hacking and phishing take.**

OUR SENSES ARE EASILY FOOLED WHY SHOULD WE BELIEVE THEM?

Background

We've been messing around with optical illusions for hundreds of years. For the Victorians they were entertaining party tricks, but now neuroscientists are using them to understand how our brains actually process what we see. Or more accurately what our brains think we should be seeing. Our visual system is simply too limited to accurately deal with the millions of images it has to process every day. *"For that our brain would need to be bigger than a building, and then still it wouldn't be enough"* - Susana Martinez-Conde

HAVE YOU EVER WONDERED

… why some people feel seasick when playing Virtual Reality games? Or how our brains are tricked into thinking optical illusions are moving?

Questions Framed for Scientific Investigation

- **How do Virtual Reality games work?**
  - Why do some people feel sick after playing them?
  - Why do we think that the images are moving?
- **What are the limits of our senses?**
  - How little light do we need to see?
  - Is your hearing "really" better if you can't see?
- **Is there any "purpose" to optical illusions?**
  - How do people like neuroscientists, psychologists, engineers and architects use them?

Off-Piste…

- **Does colour influence flavour?**
  If I eat a green sweet would it taste more like apple than if it was blue?

CAN WE BE BETTER EQUIPPED TO EXPLORE THE UNIVERSE?

Background

The Higgs Boson, Neptune and radio waves were all found using the same thing – maths. When faced with maths at school it is easy to think that arithmetic and algebra are all there is to maths. When you look around you may see some numbers on your phone, in a book these are simply symbols we have created, rather than reflecting the underlying nature of the universe in any real way. However, there are many recurring shapes and patterns in nature that are summarised in physics and can be described by mathematical "language". This leads us to question whether there are better ways for us to understand and explore the universe that reaches beyond our understanding of the universe at the "human" scale.

HAVE YOU EVER WONDERED

…Why there are so many repeating patterns in nature? Or whether it is easier to repeat a pattern in 2D or 3D?
…How we might be better equipped to investigate the universe?
Or how an astronaut can survive being hit by space debris?

Questions Framed for Scientific Investigation

- **How might we be better equipped to investigate the universe?**
  - How can/have we developed protection/ equipment in space?
  - How might the human body be adapted in the future?
- **What would be needed to live on Mars?**
  - How could we make Mars more like earth?
  - How could we adapt humans to cope?

Off-Piste…

- **Why are there so many repeating patterns in nature?**
- **How do we use fractals in technology or how they occur in nature?**

WHAT OTHERS ARE SAYING?

OECD - Organisation for Economic Co-operation and Development

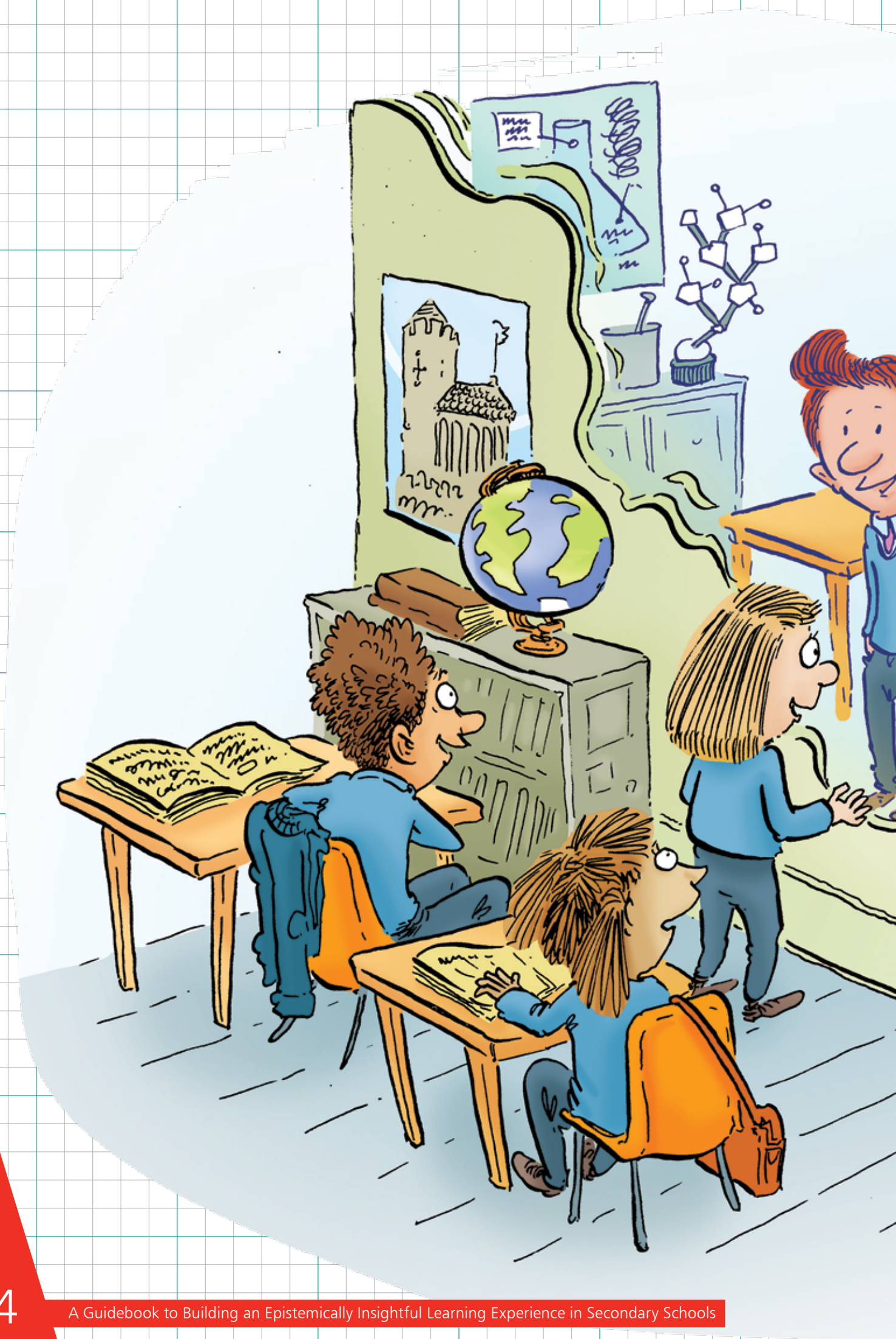
The Future of Education and Skills 2030 project
How do we enable students to be 'future-ready'? …

'Disciplinary knowledge will continue to be important … together with the capacity to think across the boundaries of disciplines and "connect the dots". Epistemic knowledge, or knowledge about the disciplines … will also be significant, enabling students to extend their disciplinary knowledge.'

ASE response to the Ofsted consultation on a new Education Inspection Framework

The Association for Science Education (ASE) strongly supports the proposal to introduce a 'quality of education' judgement; however "some schools may simply create cross-curricular topics by mapping connections in the content across compartments - a practice that would miss the opportunity to plan teaching that develops students' appreciation of both in-discipline and across-discipline epistemology"

www.ase.org.uk/download/files/paragraphs_item-field_download_all_files-6780-0



ACTIVITY 6
KEEP IN TOUCH

If you would like further support to develop an EI lesson, Scheme of Work or activity please email to find out how we can continue to help.

If you would like to organise FREE CPD for your school or have identified an area in the curriculum that you would like support with to develop an epistemically insightful learning experience, send your ideas and questions to **LASAR@canterbury.ac.uk**

LEXICON

VOCABULARY	DEFINITION
Big Questions	A question that is intended to open-up big areas of thought and will need more than one discipline to inform (we may never arrive at a definite answer). Questions about human personhood and the nature the nature of reality, that bridge science, religion and the wider humanities. For example: Can a robot be a good friend?
Big questions and small questions	Big questions draw from multiple disciplines, whereas a small question is one that has been framed to be answered within discipline. The small question may inform our thinking about the big question.
Bridging question	A question that is pedagogically engineering to bridge two disciplines like science and history so that students can compare and contrast how discipline interpret the question, investigate the question and or and knows it has produced a good answer.
Bubble tool	An epistemological tool, which considers the level of amenability a question has to science. Therefore, is it a small question or a big question.
A question that is amenable to science	These are questions that can be answered using scientific methods and produce objective answers. "What is life?" can be viewed as amenable to science the object answer is MRS GREN
Disciplines	A branch or field of knowledge that is studied.
Epistemic Insight	Knowledge about knowledge, particularly knowledge about disciplines and how they interact.
Epistemic Insight Curriculum Framework	Statements about the nature of scholarship and knowledge that reflects the aims of the national curriculum.

Disciplinary / Epistemic knowledge	Knowledge about disciplines and the questions, methods and norms of thought specific to them. Developing an appreciation of the strengths and limitations of individual disciplines.
Discipline Wheel	An epistemological tool, which asks a big question and explores the strengths and limitations of a range of disciplines to answer the question.
Scholar	A person who pursues a field of study to develop expert knowledge.
Subjects	A school subject is a part of learning that is divided up by the national curriculum.
Think like a scholar	Explain how different disciplines investigate a question. Illustrate how another discipline [like history] is different to science.
Multidisciplinary questions	Questions that require more than one disciplinary approach to inform.
Observation	Science begins with observations of the natural world and constructing ways to explain our observations.
Strengths and limitations of a discipline	How effective a disciplines method and norms of thought are in responding to a question
Questions, methods & norms of thought	An example through the lens of Science... Questions: An amenable question for Science: 'Does the size of a parachute affect how quickly an object falls to earth?' (We can come up with an idea about how the natural world works and make predictions and decide what can be measured, observed) and repeated. Methods: Science involves generating and testing ideas about natural phenomena and objects by gathering repeatable objective observations Norms of thought: Scientific knowledge - a good answer in science helps us to understand how the natural world works and is supported by repeatable observations and measurements

Epistemic Insight

Principal Investigator: **Berry Billingsley**
Research Fellow: **Finley Lawson**
For more information email: **lasar@canterbury.ac.uk**

Canterbury Christ Church University