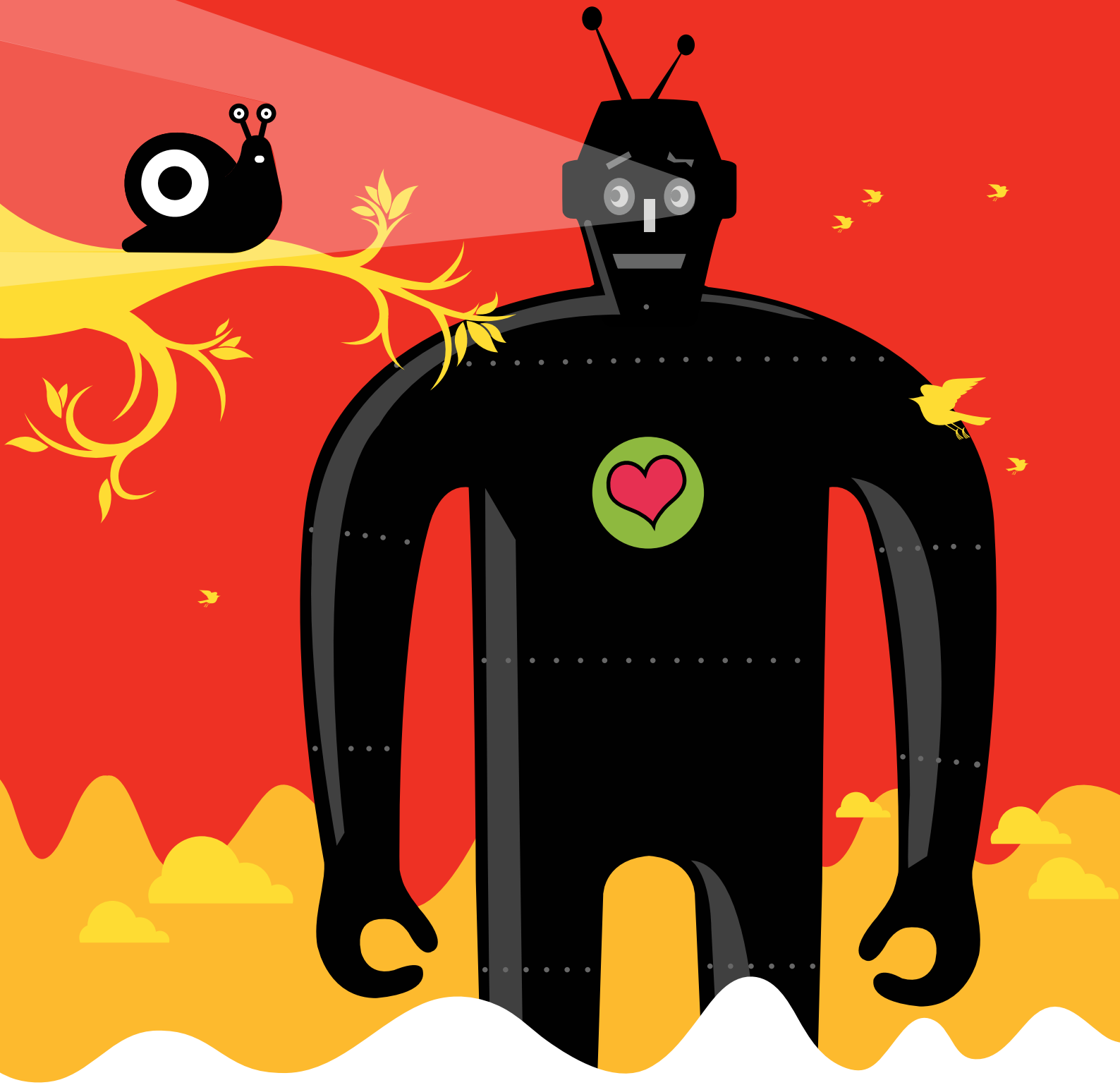
Epistemic Insight

TEACHING AND LEARNING ABOUT **EPISTEMIC INSIGHT**



Faculty of
EDUCATION

Canterbury
Christ Church
University

Principal Investigator: **Prof Berry Billingsley**,
Professor of Science Education

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CONTACT US

You can find more information about epistemic insight and the LASAR Centre on our websites:

www.epistemicinsight.com and **www.canterbury.ac.uk/lasar**

Email: **lasar@canterbury.ac.uk**

INTRODUCTION

WILLIAM STOW, PFHEA

Assistant Dean, Faculty of Education

This project gets to the heart of some key and critical issues in curriculum and the learning experiences of children in the compulsory school sector. England experiences a highly fragmented national curricula across the 5-18 age range. This, combined with the lack of connectivity in the design of the separate subject curriculum statements, can lead to a learning experience for pupils in which teachers are unable to make meaningful connections between key concepts and knowledge across curriculum disciplines.

The scale of our engagement with Epistemic Insight, both in terms of the numbers of teacher educators (both in University and in school) and the number of beginner teachers who will be involved, can create a step change in understanding about these issues. This, combined with Professor Billingsley's strong existing contacts into policy debate, creates a groundswell of voices that will influence curriculum design.

1 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 that is awash with false facts and exaggerated headlines - and equip them with the best ideas and strategies we can offer to help them make 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 future great minds of science and other disciplines the inspiration and stimulus they need?

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

Research has highlighted that schools typically provide few opportunities for asking cross-discipline and multidisciplinary questions and for exploring the distinctive approaches that different disciplines take. Further, there is a basis to say that the impacts of pedagogies like entrenched compartmentalisation are largely hidden – because assessment tends to focus only on students' progress within each subject and not the full intent of the curriculum.

Teaching epistemic insight goes hand in hand with teaching a broad and balanced curriculum. It includes building students' understanding of the ways that different types of disciplinary knowledge can help us to address questions that bridge subjects and disciplines.

THE STRATEGIES THAT WE ARE DEVELOPING

Research in Higher Education including Initial Teacher Education

Through teacher education and other interactions between higher education and schools – we will research and disseminate strategies to raise epistemic insight across the education ecosystem.

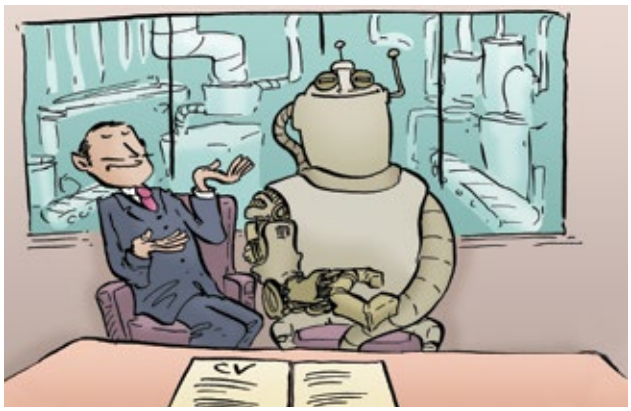
Creation and Evaluation of Intervention strategies in schools

Our research will develop a spiral curriculum to show how epistemic insight builds up as students move up through school, through college, through university and beyond.

Research to design and support a Curriculum Framework

The initiative will communicate this research via international forums to catalyse global curriculum reform. We will publish strategies, resources and pedagogies for schools and other teacher education institutions.

BIG QUESTIONS



Suppose the next candidate is a robot ...
Can a robot be a good companion for your grandmother who needs support at home?

Big Questions are questions about the nature of reality and human personhood. Some examples of puzzles today 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 and is it true that, 'you are what you eat'?

These questions bridge science, religion and the wider humanities and are frequently squeezed out of school education because they do not fit into single-discipline subject boxes and because they raise issues that are perceived as controversial.

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

The Epistemic Insight Initiative invites researchers, tutors, student teachers and teachers to find ways to teach and assess key ideas about the nature of knowledge which are squeezed out by pedagogies like entrenched compartmentalisation.

BIG QUESTIONS DAY: THE DAY OF THE LAUNCH

The Epistemic Insight Initiative launched on Thursday 16 May 2019.

More than 500 students including 200 from primary and secondary schools came onto campus for a day of asking and exploring Big Questions. Here are some of the workshops that took place.

KS2-5 WORKSHOPS

THE MYSTERIOUS CASE OF THE DISAPPEARING YARN

Mr Faraday was upset. The balls of wool he regularly bought from the wool company were shrinking. The supplier, however, claimed that the yarn is unchanged and Mr Faraday's knitting is now looser. Students explore different methods to measure objects from the very small to the very knotted to try to address both claims. Now, do we think someone is cheating or is it an honest mistake?

THINK ABOUT THIS: In law, there's a big difference between an honest mistake and deliberate cheating. Measuring the wool helps a lot with addressing the question of whether the balls of wool are shorter.

Our other question is whether someone is deliberately cheating and this question is less amenable to the methods of science and maths. We can say that measuring the wool informs our thinking (it narrows the possibilities) but does not fully resolve the question.

BRISTLE BOTS: "CAN WE EXPLORE BIG IDEAS WITH SMALL THINGS?"

Students build small robots using the tops of toothbrushes. As the bristle bots move and jostle around their terrain – they seem to be alive, so are they alive? Students consider definitions of 'life' and what happens when biology and robotics ask the same question.

KS3 Students explore a range of questions such as can a robot really have a sense of curiosity and (KS4) can a robot really appreciate music. They put questions along a line from least to most contentious.

THINK ABOUT THIS: We can refer to a list of life processes to decide whether a robot is 'biologically' alive. Now consider the bigger question– 'what does it mean to be alive?' Which disciplines can help to build an answer?

KS3-4: The framing of a question can affect how deeply we need to engage with contentious issues around personhood in order to respond. A group of individuals may agree on which questions are more or less contentious while at the same time disagreeing on how to answer some of the questions.

EVOLUTION

Students draw cacti and dinosaurs to highlight features that give them an advantage in their ecosystems. The 'bird beak activity' illustrates the point that pressures in an environment affect how populations evolve. In natural selection, natural variation between the living things in a population means that some are more likely to survive and pass on their genes than others. Artificial selection (such as breeding) and artificially changing landscapes also influence the ways that many species evolve.

THINK ABOUT THIS: Natural selection does not 'plan ahead' or judge the wisdom of its mechanisms. Even so, via evolution there is a huge diversity of living things today including people. Some people say that evolution is part of God's purposeful creation. Some others say that reference to God is unnecessary and that chance and evolution alone explain why a diversity of living things exist.

KS3: Science informs our understanding of our collective responsibilities. Threats facing biodiversity include habitat destruction and fragmentation and also influences on individual survival and reproductive rates and introduction of alien species.

GENES, DETERMINISM AND HUMAN IMPROVEMENT

Explore the relationship between genetics, determinism and identity. Modern science has given us great power to intervene in human life, how does our evolving understanding of what makes us "persons" influence how we define who we are.

THINK ABOUT THIS: KS3: Consider the big question, 'Can science help us to make better humans?' We could be more specific and add 'better for what?' How do people's answers change if we narrow down the question by changing 'better' to 'healthier'?

KS4-5: By analysing your own and other people's perspectives on what makes us human, can you demonstrate an appreciation that some questions are more metaphysically sensitive than others?

HOW DO WE KNOW WHAT WE KNOW?

Perhaps one day a supercomputer will predict the outcome of every scenario


Meanwhile we
can work some
things out for
ourselves


BUT WHY DO WE GO TO SCHOOL?!

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

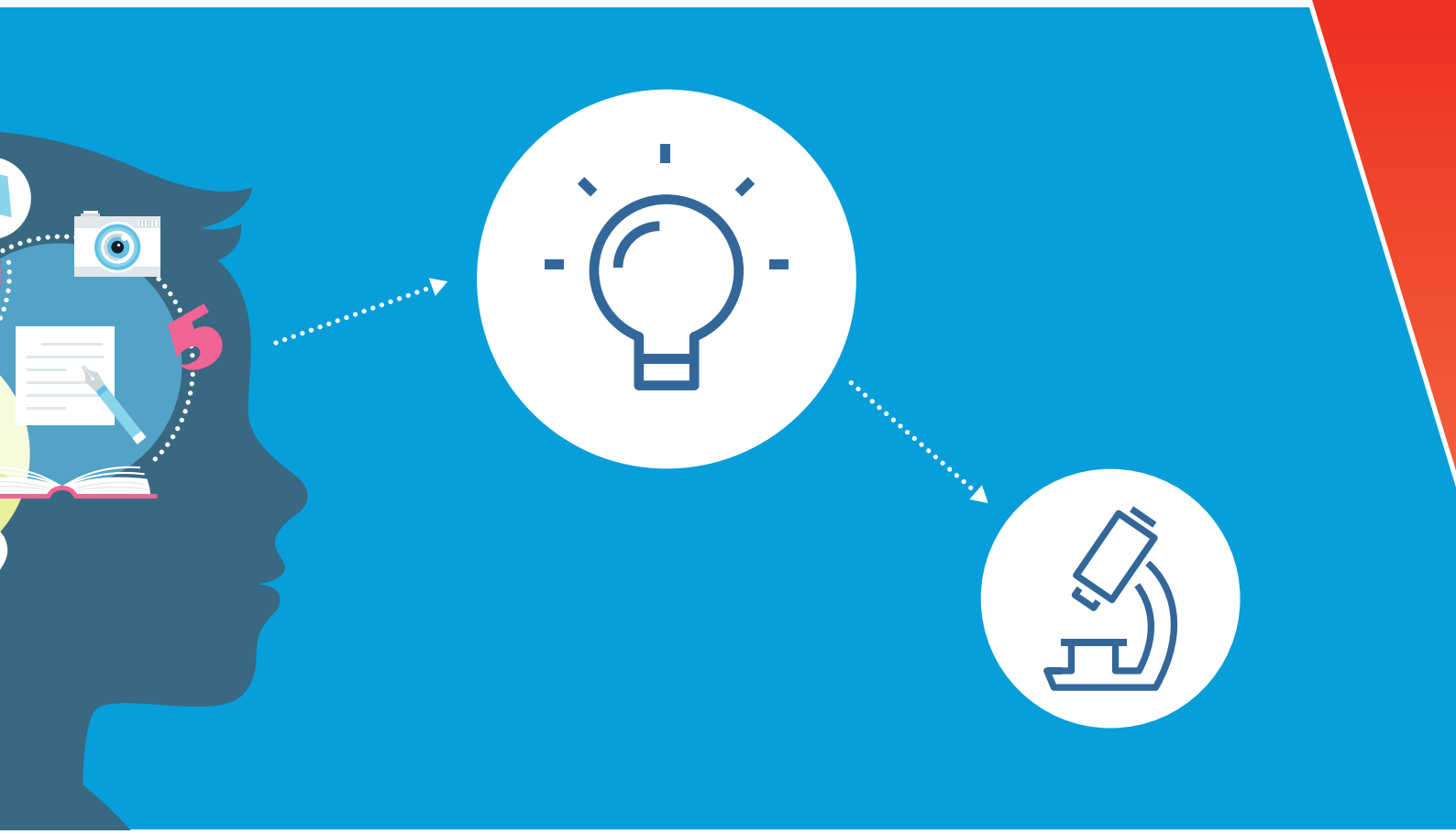
At school we learn about scholarly knowledge and how to think like a scientist, historian, geographer, musician…

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.

2 THE ESSENTIAL RESEARCH BACKGROUND

MONDAY	TUESDAY	WEDNESDAY	THURSDAY	FRIDAY
Registration	Registration	Registration	Registration	Registration
Maths	History	Biology	Physics	English
Break	Break	Break	Break	Break
Geography	English	Art	Maths	Chemistry
Lunch	Lunch	Lunch	Lunch	Lunch
History	Science	Sport	RE	Maths

We each spend many years at school – engaging with increasingly complex ideas, skills and ways of thinking that are mostly organised into different subjects. The teacher's role includes creating ways to teach the curriculum and assessing students' progress. We know that what school students learn in any given lesson doesn't necessarily look like what we intended to teach. Assessment is a source of feedback that helps teachers to evaluate the strategies they are using and find more effective ways to teach.

Research in education is focused even more strongly on the question, 'How can we make education better'? We rarely if ever name students taking part – and we explain to students that by taking part, they are helping us to improve how we teach.

The LASAR (Learning about Science and Religion) centre investigated the ways that Big Questions that bridge science, religion and the wider humanities are managed in schools. The findings uncovered some of the unintended impacts of some of the strategies that we commonly use on students' experiences and what they are learning to think. In the examples and quotations below, participants' names have been replaced by pseudonyms.

ENTRENCHED COMPARTMENTALISATION

For many decades the practice at almost every level of education has been to teach students about scholarship and knowledge via a compartmentalised system of individual curriculum boxes. The walls around the compartments are created by curriculum documents, examinations, teacher education and – in secondary schools –specialist teacher recruitment and subject specific classrooms (Cloud, 1992; Ratcliffe, 2009).

Immersing students in the questions, methods and norms of thought of a single discipline at a time is important to help students to get a feeling for how each discipline works and there is no intention here to do away with subject compartments. At the same time students also need opportunities to see the value and significance of questions which do not sit neatly in one subject or another. They also need to move successfully between their subject compartments, feeling that what they learn in one subject still makes sense – and can even be useful - when they move into another. An interview study with science and RE teachers in eight schools discovered that they rarely if ever collaborate to plan or deliver their teaching (Billingsley, Riga, Taber, & Newdick, 2014). The comments below were typical:

> *"We've had no cross-curricular sessions here since I've been here – which is (pause) 19 years. [laughs] I think they may be useful, so that at least we know what [the] teacher there is teaching."* (science teacher)

> *"There is no relationship between Religious Studies and science ... it is very hard for pupils to actually see where those two can work together." (science teacher)*

> *"I'm not terribly familiar with the science curriculum; I don't think they're terribly familiar with mine." (RE teacher)*

What makes a question a science question... well it says it's science in the timetable, it says science on the front of the book - and in secondary - it's the name on the door and the job title of the teacher!

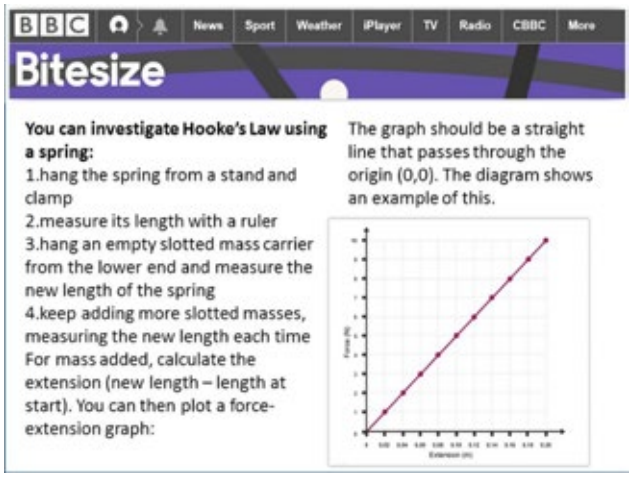
When subject compartmentalisation becomes entrenched it means that organisational, social and pedagogical practices have become habits and now dictate students' and teachers' expectations about what should happen in the classroom (Billingsley, Nassji, Fraser, & Lawson, 2018).

Our findings resonated with the findings of previous research – which says that the science classroom tends to have the most impermeable boundary of all (Bernstein, 2000). Fourteen year old David explained that he would hold back a question in a science lesson that would take the teacher 'off-topic' (Billingsley, Taber, Riga, & Newdick, 2013).

In many lessons it may not even occur to the teacher or the students that a question they are addressing in science could also be explored through the lens of another subject or discipline. Christine (age 13) said that, "When I'm in science, I don't think about religion sometimes, because […] it just doesn't come into your head" (Billingsley et al., 2013, p. 1726).

3 COMPARING AND CONTRASTING SCIENCE AND RELIGION

WHAT IS SCIENCE LIKE?



Recipe Investigations
Students are told - what to investigate, what to do and what the 'right answer' looks like.

When school students are asked to describe science – they typically say that science consists of facts, experiments, right answers and proof (Driver, Leach, Millar, & Scott, 1996; Leach, Hind, & Ryder, 2003). Educationalists discussing why these ideas are common often point to the use of so-called recipe investigations as a big part of the picture (see for example Abrahams, 2017).

Recipe investigations are practical activities where students are guided by a set of instructions. Teachers use recipe investigations to help students to understand well known scientific concepts and relationships – but what students frequently conclude is that science is always right and their experiment has 'failed' if it doesn't get the 'right answer' (Billingsley et al., 2018; Longshaw, 2009).

The BBC Bitesize summary of an "investigation" students can do to confirm Hooke's law is an example of a recipe investigation (in the illustration above).

LEARNING ABOUT RELIGION

We noted that in interviews, students tend to characterise science as facts, experiments and proof. In contrast religion is often said to be about "beliefs", "opinions" and "choices" – and in religion "you can believe what you want". Isobel (Year 9) explained that

> *"In RE lessons it's an open discussion . . . there's still that freedom in RE to choose your own beliefs . . . whereas in science there is much more taking notes and 'This is how it is,'" (Billingsley, Brock, Taber, & Riga, 2016, p. 473)*

Brenda age 14 told us that her decision about which to believe is made on faith grounds:

> *"I think God created the universe, but if you don't have a religion, then you might think that it was the Big Bang. Because I have a religion, I think it was God who created it." (Billingsley et al., 2013)*

MISSING OUT?

Pedagogies like entrenched compartmentalisation and the overuse of recipe investigations in schools mean that many students are missing out on investigating a range of ways that areas of knowledge can interact including positive ways. This is unfortunate as comparing and contrasting discipline can help students make sense of words and ideas like 'evidence' that are referred to in many subjects and modules. Big questions that go beyond science also provide exciting opportunities to reflect on the scale of the universe, the complexity of real life and the value and limitations of what we know so far.

Scientism is a belief and attitude that science is the only valid way to construct knowledge and that nothing exists beyond the material universe (Stenmark, 2013). We recommend that students explore big questions and find out what scientists and other scholars say about the power and limitations of science. By doing so, students can appreciate that there is a range of stances – and avoid the misperception that a scientist has to commit to scientism. The comments that follow are by 10 year old students. They seem to us to indicate a kind of uncritical scientism:

> *"Well, if it wasn't for science we wouldn't know much about the world or anything, really."*

> *"I only believe science and logical answers and theories"*

> *"I think the universe was up to science and science did everything."*

CONCLUSIONS

In a series of research studies, LASAR looked at how questions that bridge science, religion and the wider humanities are managed in schools. In our conclusions we described the experience of school as a journey. As students travel from subject to subject and key stage to key stage, there is no one pivotal moment at which their curiosity about Big Questions is suddenly silenced or extinguished. Nor is there one moment or lesson that means that many of them conclude that science is in competition with religion. Instead, where students are hiding or losing their curiosity about Big Questions and in some cases, learning to live with a sense of confusion about how science and religion relate, we need to look at what teachers are saying – or not saying - at many points on the journey.

As problems go, that makes this a tricky issue to address. This isn't about making a difference for one age group or in one subject. It's about collaborating across the subjects and key stages, to discover and test the impacts of little changes that can happen at each point. The research indicates that there is a medley of pressures, barriers and missed opportunities that dampen students' developing curiosity about Big Questions and leave many with gaps and misperceptions about how scholarship and knowledge work (Billingsley, 2017; Billingsley et al., 2018).

We hope you agree that by researching and working together, we CAN make education better.

4 THEORY OF CHANGE

The Epistemic Insight Initiative involves eight Higher Education institutions, led by Canterbury Christ Church University, with funding from the Templeton World Charity Foundation, the Royal Academy of Engineering, The National Collaborative Outreach Programme and All Saints Education Trust. The LASAR (Learning about Science and Religion) team and the Faculty of Education have been awarded more than £1.5 million to carry out the research.

The Epistemic Insight initiative will include researchers, university tutors, pre-service teachers, mentors, teachers, outreach ambassadors and many more people collaborating to create and test new strategies.

These strategies are designed to develop students' expressed curiosity about Big Questions and to help schools to provide opportunities for dialogue about questions that bridge subjects and disciplines.

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

Pre-service teachers have opportunity and motivation to engage with the research and to develop their own strategies to improve the experiences they provide to the children they teach.

Some of the related advantages we anticipate are more enthusiasm for studying science and for science related careers and improved attitudes among some students towards their subjects.

In these ways the Epistemic Insight Initiative aims to help schools to:

- Develop students' curiosity and capacity to express questions that bridge disciplines and subjects including Big Questions (questions about the nature of reality and personhood that bridge science, religion and the wider humanities)
- Explain the characteristics, potential and limitations of a range of disciplines and areas of knowledge, how they interact to inform our thinking about different types of questions and why the framing of questions matters.
- Design, carry out and evaluate enquiries that demonstrate a growing ability to think more deeply, compassionately and critically about Big Questions.

5 THE EPISTEMIC INSIGHT CURRICULUM FRAMEWORK FOR SCHOOLS

Over a three year research cycle, the Initiative will refine a draft framework for enabling the development of Epistemic Insight. It sets out a learning sequence with objectives in each of three categories for school students aged 5-16 (Billingsley et al., 2018).

- One category focuses on ways to develop students' interest in Big Questions and ways to teach about the relationships between science and religion.
- A second category has strategies to teach about cross-discipline relationships between science and other disciplines studied in school and ways to explore questions about the power and limitations of science.
- The Framework has a third category with strategies to develop students' understanding of different ways of knowing and how they interact.

Draft EI Framework for Education: Learning Objectives

Year Level	Relationships between science and religion	The nature of science in real world contexts and multidisciplinary arenas	Ways of knowing and how they interact
Primary Learning Outcomes	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.	Science has some similarities and some differences with other ways of knowing that we learn about in school.
Lower secondary Learning Outcomes	Some people say that science and religion are compatible and some people say they are not.	Some questions are more amenable to science than others.	Different disciplines have different preferred questions, methods and norms of thought.
Upper secondary Learning Outcomes	Science and religion are not necessarily incompatible.	Scientism is not a necessary presupposition of science.	Some questions are more metaphysically sensitive than others.

6 TEACHING EPISTEMIC INSIGHT

Teaching epistemic insight includes teaching students how to work with questions that are framed to be explored in one discipline and also those that are cross-discipline – or in other words, framed to bridge two disciplines. It also includes teaching students how to analyse and construct these different types of questions for themselves.

Questions can be explored in many different ways – even though they may appear to be more suited to one discipline or another. When we communicate knowledge it is important to explain what frame we used to acknowledge the limitations of any answers we found. An answer in science may be sufficiently true for the criteria we used when carrying out the investigation but it is unwise to rush into making bigger claims.

EXAMPLES OF SINGLE AND CROSS-DISCIPLINARY TOPICS

Here is a question that is framed to be suited to science – or in other words, a question that is amenable to science:

What are the factors that affect how quickly or slowly a sheet of paper falls to the ground – does it make a difference if I scrunch it up?

Can you frame some other questions that are amenable to science? What about the following question – is it framed for one discipline or more and if more than one, which would you suggest?

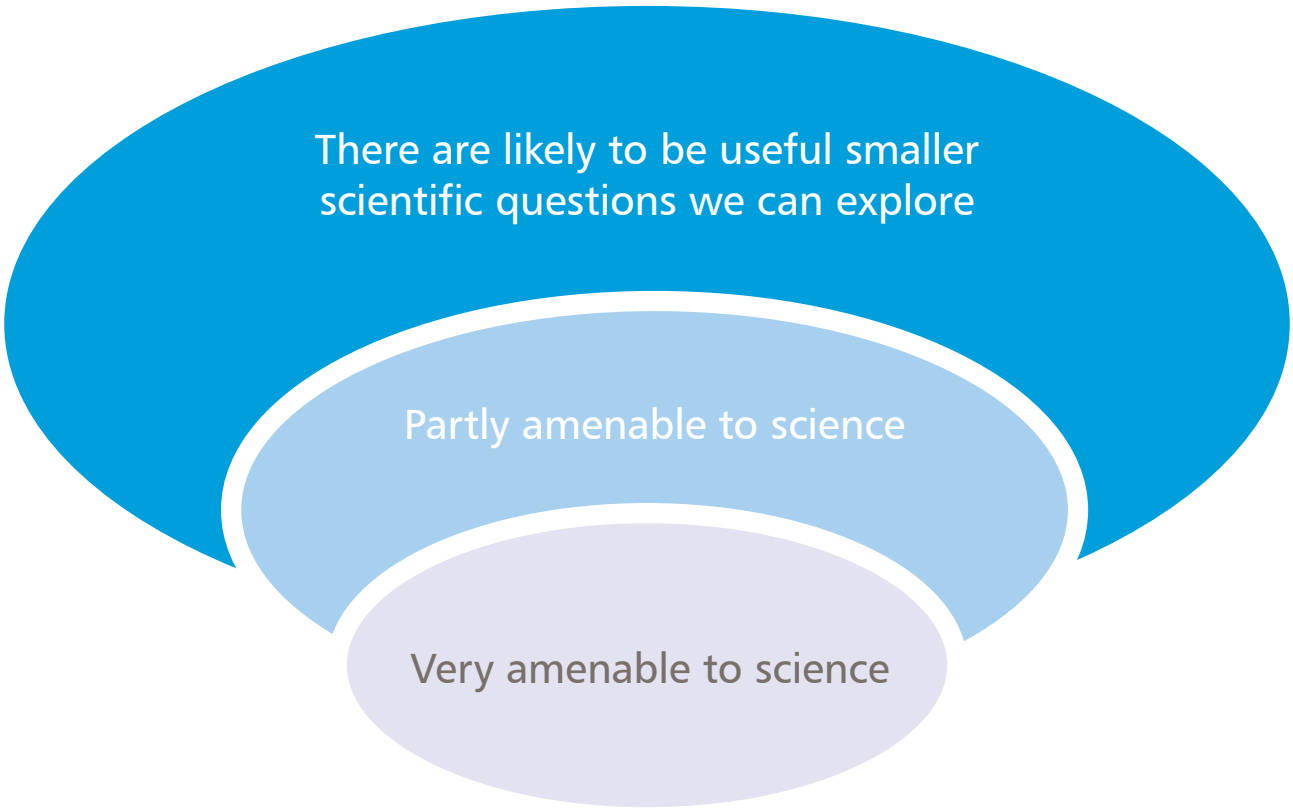
Why did the Titanic sink?

Are there any topics that you are teaching at the moment where you could explore writing and analysing different types of questions with students? Can you find or create some questions that seem to be very amenable to one discipline rather than any others – and some questions that are good ones to investigate across two disciplines? What about this one – which one or two disciplines would you suggest:

How many milk bottle tops would you need to make a continuous line of bottle tops around the outer edge of the table?

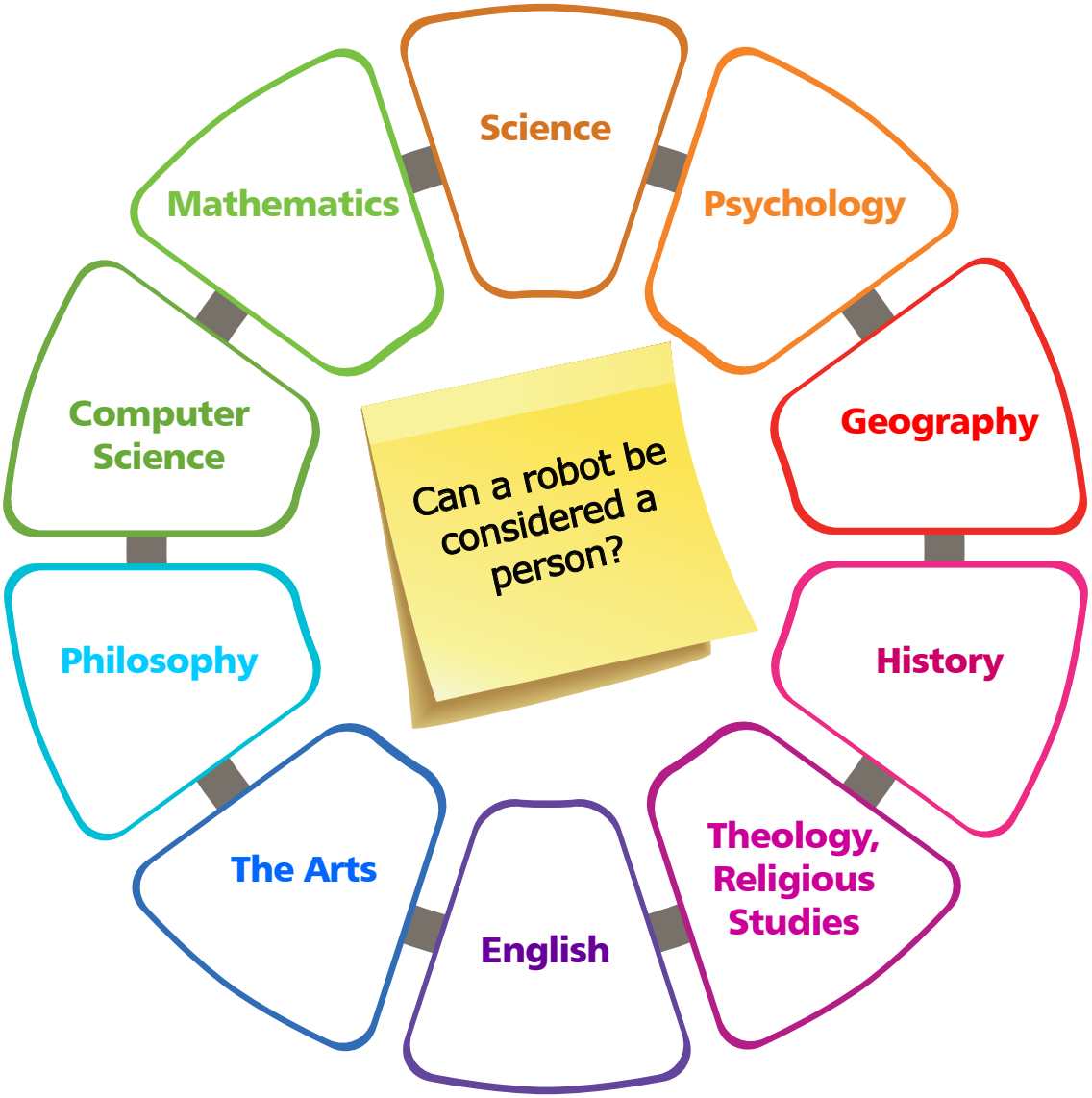
The Bubble tool is a tool that you can use to look at whether a question is amenable to a particular discipline – in this case science. A question may be framed to be very amenable to science. Another question might be a very big question – and in that case it is likely that we can use science to inform our thinking by framing and addressing smaller questions. Try it for yourself...

SCIENCE BUBBLE



1. Why did the Titanic sink?
2. What is the most interesting book ever written?
3. Why did the great fire of London spread so quickly?
4. Why do things fall to the ground when you let them go?
5. Would a robot ever be given the status of an electronic person?
6. Why did the Romans come to Britain?
7. Will we ever bring back dinosaurs?
8. If Henry VIII's first wife had given birth to a baby boy, would he have remarried?
9. Why did many women authors write under male pseudonyms?
10. How can we measure the speed of coastal erosion?
11. Is trial by jury the fairest way to judge someone?
12. Is it possible to make a square bubble?
13. Can one survive a lightning strike in a moving car?

DISCIPLINE WHEEL



To use the discipline wheel, place a question or topic of discussion in the middle. You can ask a very big question, such as "what makes us human?", or what might at first appear to be a question that is specific to one discipline/subject such as "Why does water boil at 100 degrees Celsius?". You can also pose conundrums such as "why are there flightless birds on all of the continents if birds evolved after the continents separated?"

You can then go through the different disciplines in the wheel, and try to view the question or topic through that particular perspective: how do theology, politics and mathematics seek to answer "what makes us human"? What can the arts, physics, economics and psychology say about this question? In this way, you can show students how the different disciplines connect across topics and questions, and how much is lost if we only use one discipline lens to learn about and make sense of our reality.

For more information and resources, visit
www.epistemicinsight.com

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CONTACT US

You can find more information about epistemic insight and the LASAR Centre on our websites:
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If you would like more information you can also contact the LASAR team on **lasar@canterbury.ac.uk**

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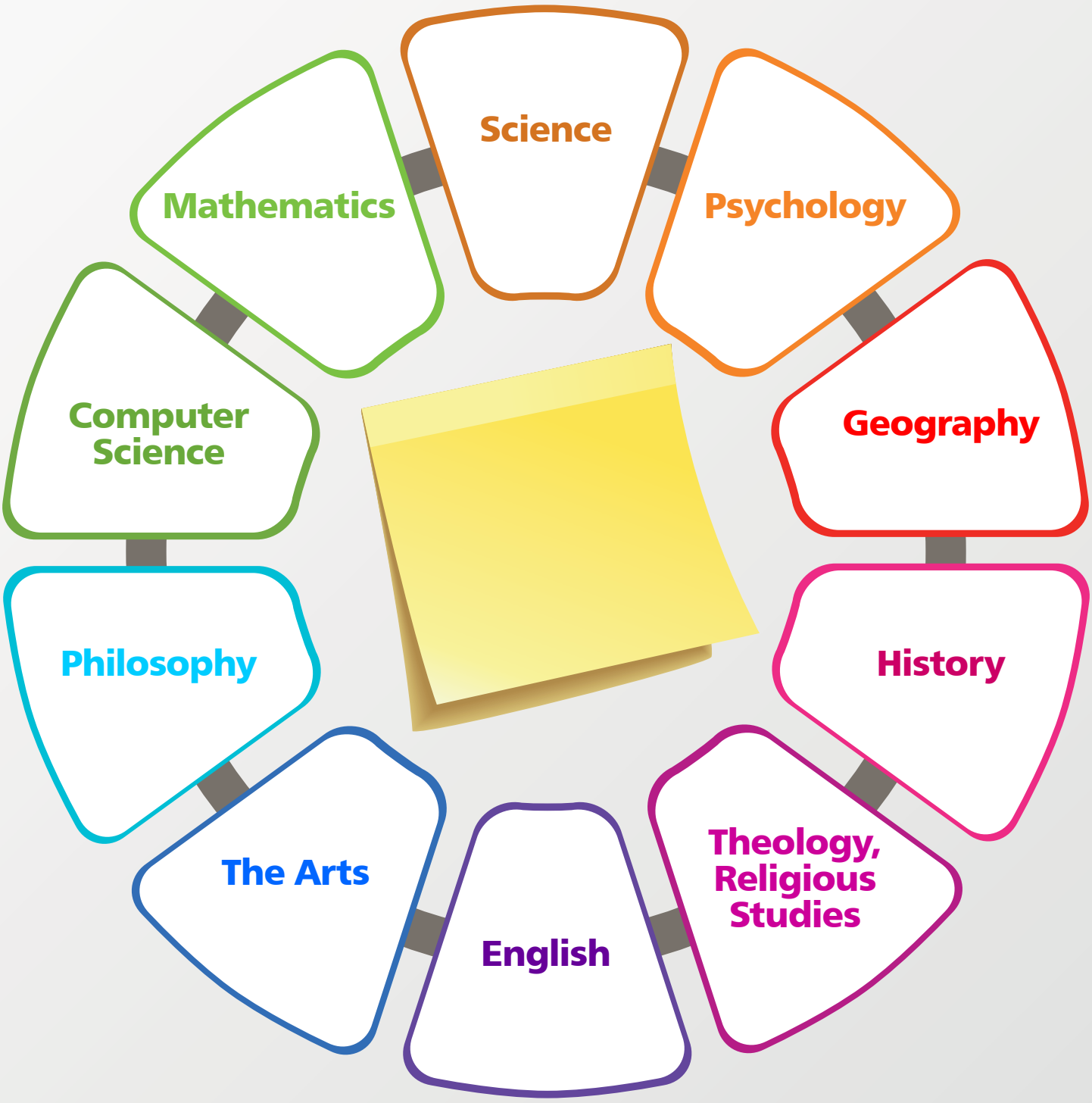

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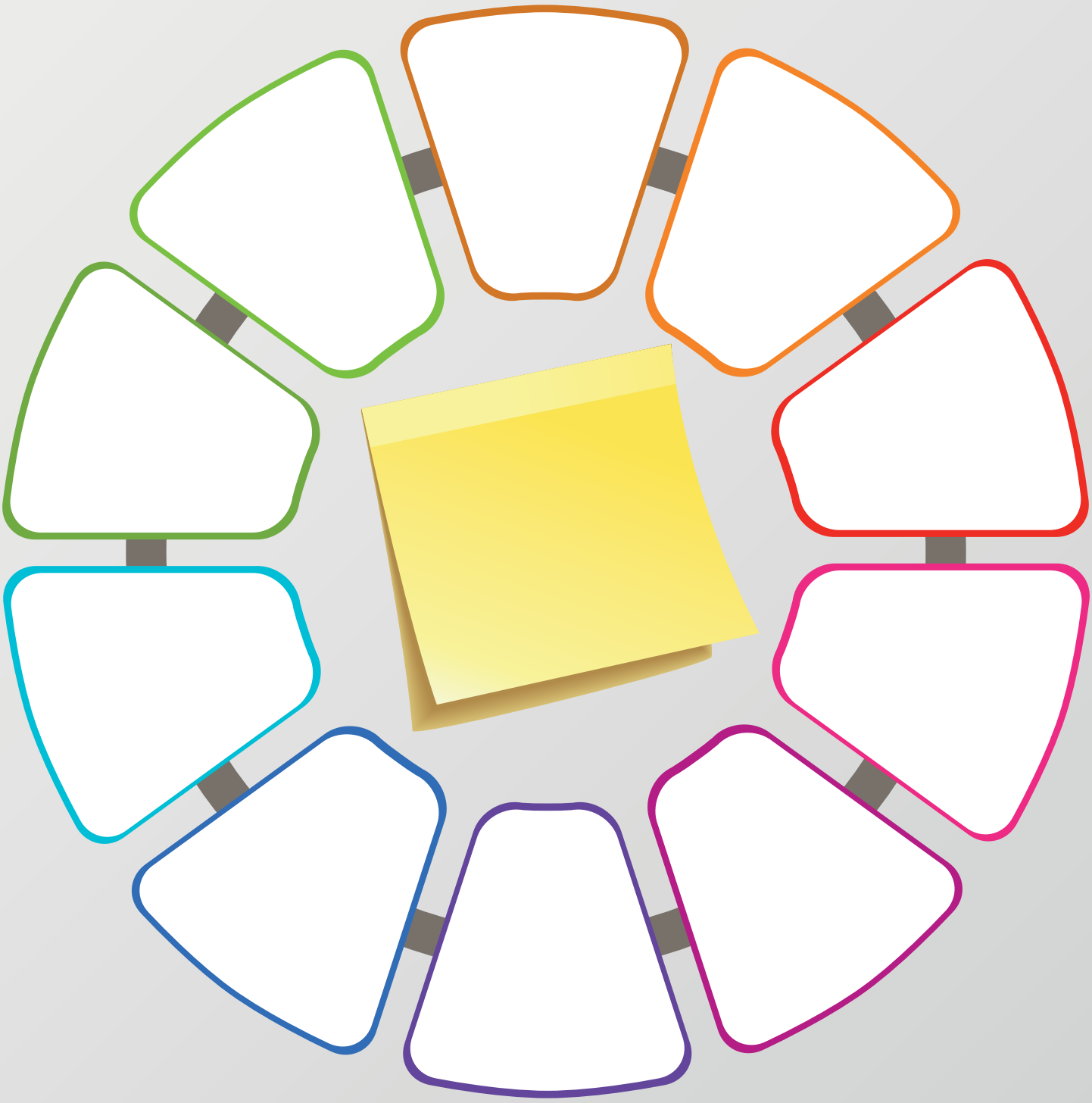

Canterbury Christ Church University

Epistemic Insight

FACULTY OF EDUCATION
Canterbury Christ Church University
North Holmes Road | Canterbury | Kent CT1 1QU

education@canterbury.ac.uk
www.canterbury.ac.uk/education

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