IB DIPLOMA
IB
STUDENT MAGAZINE
Review
November 2017 Volume 4 Number 2
TOK questions
Can paradigm shifts occur in the human sciences?
Extended essay skills
Scoring top marks for reflection
Chiastic structure in Frankenstein
Should you take the ab initio?
What is justice?
Collecting data for your biology internal assessment
Mathematics activities to aid your learning
Approaching the textual analysis and comparative study
Expert advice for the external film assessments
eMagazine available
HODDER EDUCATION
LEARN MORE

IB review

Editor
John Sprague, Tanglin Trust School, Singapore

Consultant editor
David James, Bryanston School, UK

Associate editors
Oliver Bowles, International School of Toulouse, France
Nathalie Fayaud, Sevenoaks School, UK
Paul Hoang, Sha Tin College, Hong Kong
Breen O'Reilly, International School of Beijing, China

Contact IB Review

We would welcome your feedback and comments on the articles in this issue of IB Review, and also your suggestions about what you would like to see in future issues of the magazine and for our online extras. Please e-mail us at **magazines@philipallan.co.uk**

How to subscribe

Contact your local sales agent, details at:
www.hoddereducation.com/agents

OR

For schools in the UK and Europe, contact Magazine subscriptions, Bookpoint Ltd, 130 Park Drive, Milton Park, Abingdon, Oxfordshire, UK OX14 4SE

Telephone: +44 (0)1235 827827 Fax: +44 (0)1235 400401
E-mail: **subscriptions@bookpoint.co.uk**

For further information go to:
www.hoddereducation.co.uk/magazines

Published by Hodder Education, an Hachette UK company, Blenheim Court, George Street, Banbury, Oxfordshire, UK OX16 5BH

ISBN: 978-1-4718-9163-2
Use the ISBN above to order more copies at
www.hoddereducation.co.uk/magazines

© HODDER & STOUGHTON LTD 2017

ISSN: 2055-1037

Cover image: AF Archive/Alamy. Other photos are reproduced by permission of Ivan Kopylov/caymia/Dmitry Nikolaev/napatcha/Vladimir Floyd/Katrina Brown/andreykr/finevector/vempireart/Julien Eichinger/vectorfusionart/Fotolia, AF Archive//Moviestore Collection/Alamy, TopFoto, Ingram, ImageDJ/Cadmium.

Publishing editor: Ollie Judkins
Artwork: Chris Bladon Design
Printed in Great Britain

The paper on which IB Review is printed is sourced from managed, sustainable forests.

All website addresses in the articles are correct at the time of going to press. IB Review does not take responsibility for the content of any listed sites.

IN THIS ISSUE

2 Can paradigm shifts occur in the human sciences?

16 What is justice?

eMagazines

IB Review is also available as an eMagazine:

- Downloadable to any two devices
- Lets you add, edit and organise personal notes
- Ongoing access to the whole volume (no expiry date)

Student subscriptions can be purchased and set up through your school at:
www.hoddereducation.co.uk/magazines

Next

IB Review
Volume 4 Number 2 November 2017

IB review update

Look out for *IB Review update*: a topical article and activities by John Sprague e-mailed **FREE** in October, December and March.

To receive yours register today at **www.hoddereducation.co.uk/magazines**

Free online resources

No log-in required. For this issue's extras go to: www.hoddereducation.co.uk/ibreviewextras

TOK poster
Display the key facts about paradigm shifts

Lesson plans
Using the magazine articles in class

Teaching notes
Ideas for teaching the topics in the magazine

CONTENTS

2 **Theory of knowledge**
Can paradigm shifts occur in the human sciences?
Chris Coates
TOK

6 **Approaching the external assessments**
Breen O'Reilly
FILM

10 **Chiastic structure in *Frankenstein***
Priscilla Biddle
ENGLISH

14 **IB alumni**
Jamie Bilbow: celebrity chef

16 **What is justice?**
Sian May
PHILOSOPHY

20 **Theory of knowledge**
Paradigm shifts
Chris Coates
TOK

22 **Extended essay**
Writing and reflection
John Cannings
EE

26 **Should you take the ab initio?**
Alessandra Symons and Rod Rands-Webb
LANGUAGES

28 **Activities to aid your learning**
Julia Tsygan
MATHEMATICS

31 **Elkington's triple bottom line**
Paul Hoang
BUSINESS MANAGEMENT

34 **Collecting data for your internal assessment**
Pierre Dawson
BIOLOGY

38 **Theory of knowledge**
Serendipity and scientific discoveries
Germán Tenorio
TOK

42 **Theory of knowledge**
Decisions decisions… are not really TOK
John Sprague
TOK

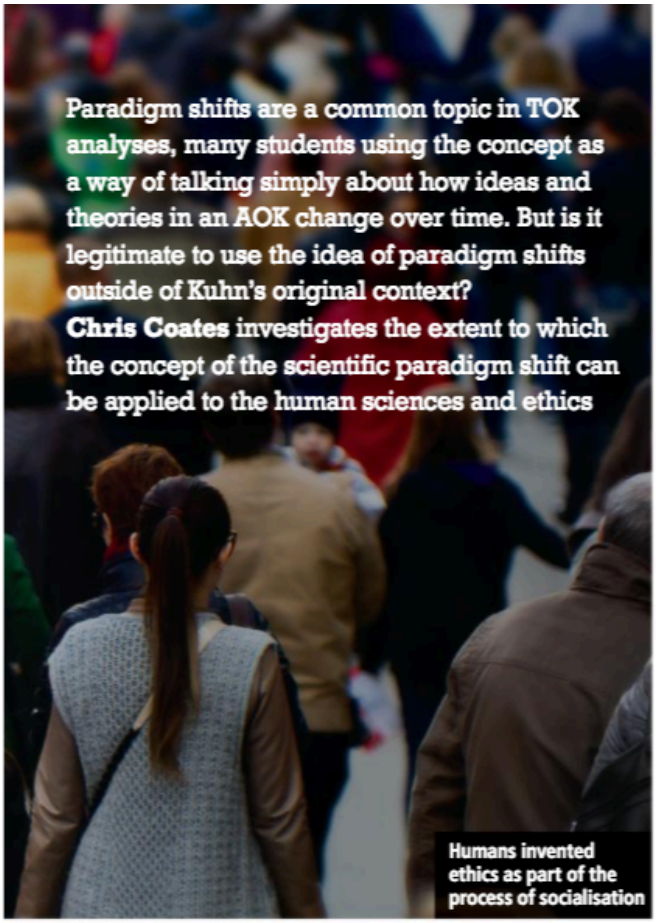
TOK THEORY OF KNOWLEDGE

Can paradigm shifts occur in the human sciences?

The term 'paradigm shift' was defined by Thomas Kuhn in his 1962 book *The Structure of Scientific Revolutions* (1962). A **paradigm** shift involves the replacement of a scientific theory with another, in the light of new evidence that cannot be reconciled with the older theory (see IB Review, Vol. 3, No. 2, pp. 14–17). For Kuhn, a true paradigm shift means that the new theory is *incommensurable* with the old — that is, you cannot simultaneously accept both theories. Two theories are incommensurable if the conceptual frameworks that they introduce do not overlap.

Kuhn called the process of overturning the old paradigm and adopting the new **scientific revolution**. Such revolutions are rare, as they involve building a consensus among the whole community of scientists. Powerful evidence and a compelling new theory or model is needed. Such evidence is likely to involve empirical observations that cannot be reconciled with the old theory, and the new theory will be compelling to scientists if it is better able to solve problems.

In TOK we explore the historical development of areas of knowledge (AOKs) as part of the knowledge framework. So to what extent is the paradigm shift concept useful in AOKs other than the natural sciences? Do they also develop through these occasional fundamental shifts in thinking? Or is knowledge construction more likely to be gradual and incremental, leading to expansion of knowledge, rather than displacement of it?



Paradigm shifts are a common topic in TOK analyses, many students using the concept as a way of talking simply about how ideas and theories in an AOK change over time. But is it legitimate to use the idea of paradigm shifts outside of Kuhn's original context?
Chris Coates investigates the extent to which the concept of the scientific paradigm shift can be applied to the human sciences and ethics

Humans invented ethics as part of the process of socialisation

Exam context

After reading this article you should be able to:
- describe the stages of a knowledge revolution or 'paradigm shift'
- describe examples of such changes in the AOKs of human sciences and ethics
- discuss the nature of 'progress' in the historical development of these AOKs

The five phases

In *The Structure of Scientific Revolutions* Kuhn identified five phases of paradigm shifts:

- **Phase 1: pre-paradigmatic state**: there is no consensus on the theory or paradigm to be used.
- **Phase 2: normal science**: the practitioners accept a paradigm (there is a consensus) and work is focused on exploring the details of the paradigm.
- **Phase 3: crisis**: some of the work produces results that don't fit the paradigm. Efforts are made to modify or adjust the theory to help these problem results to fit. Other candidate theories may emerge which explain the results better.
- **Phase 4: revolution**: eventually there are so many problems that the existing paradigm is overturned. A new theory is adopted which better explains the results.
- **Phase 5: post-revolution**: normal science resumes. The details of the new theory are gradually established. The practitioners are now working within the new paradigm. The previous paradigm still exists as historical knowledge, but is no longer used by serious practitioners.

See pp. 20–21 for a full description.

Knowledge revolutions

The TOK guide describes the human sciences as 'the study [of] the social, cultural and biological aspects of human existence', and points out that the phenomena described in the human sciences are less likely to possess 'hard and fast laws that admit no exceptions'. Do the 'human' aspects of the human sciences make them less likely to be based in a consensus than the natural sciences? Without such consensus, can true paradigm shifts occur? We will consider two subjects from within the human sciences: psychology and economics.

Psychology

Of the human sciences, psychology is perhaps the closest to a natural science in its use of experimental methods. As McLeod (2011) explains, some believe that psychology *is* a natural science, and it has undergone several paradigm shifts in its relatively short history, for example:

- **Functionalism**, as proposed by William James, studied mental behaviour in terms of how the organism adjusts to its environment. This was challenged by…
- **Structuralism**, as devised by Wilhelm Wundt which attempted to use introspection as a means to break down mental process into constituent parts. This was then challenged by…
- **Behaviourism**, championed by B. F. Skinner, which posits that stimulus and behaviour can be linked without needing to propose subconscious mechanisms of thought or consciousness.

These different psychological theories certainly represent different ways of thinking about the subject. However, none of the theories described attained the *consensus* required to be a true paradigm. In Kuhnian terms, psychology is still pre-paradigmatic — the work outlined above represents attempts (so far unsuccessful) to establish a consensus as to how psychology should be conceptualised.

Psychological studies often rely on self-reported data such as measures of happiness

Was the move from Keynesianism to monetarism an example of a paradigm shift in economics?

But what might we mean by *ethical* progess? Ethical knowledge has clearly undergone changes throughout history. Some oft-cited shifts in ethical norms include changing attitudes towards women, race and homosexuality in countries around the world. Although we might feel instinctively that such changes in attitudes represent progress, it is worth questioning these moral assumptions.

Some moral philosophers claim that there are objective moral truths that exist independently of our feelings or attitudes. This concept is called **moral realism**. In a Kuhnian sense, ethical progress would mean that our attitudes and behaviours become more closely aligned with these external moral facts, in the same way that scientific knowledge gets closer to describing the objective reality. The problem is that we are unable to make empirical measurements or observations of these ethical facts.

A moral relativist might claim that since these ethical facts cannot be established, then ethical changes cannot be said to represent progress, as we have no way of knowing whether we are getting closer to the truth. A scientific model of progress towards truth would not apply.

However, a Kuhnian revolution also includes more pragmatic aspects — the new framework or paradigm is more functionally useful in solving problems and suggesting fruitful questions and avenues of research. Might ethical progress exist in this sense?

In *The Ethical Project* (2011) Philip Kitcher argues that ethics evolved as humans established social groups, moving beyond animalistic behaviour into a much more social and cooperative mode. Essentially, humans invented ethics as part of the process of socialisation. We might argue, therefore, that the consensus paradigm is the establishment of societal rules that sanction certain kinds of behaviour. The change in ethical norms over time is analogous to Kuhn's normal science — the gradual working out of problems.

As the circles of human interaction have grown over millennia, the need to formulate societal norms for the treatment of more groups of people (women, other ethnic groups, other sexualities) has expanded. This constitutes progress, not only because such changes in attitudes are right and good, but because they solve the problem of enabling us to live together in a pluralistic society.

An alternative view might be that the ethical changes we have seen throughout history *do* deserve the status of paradigm shifts. For example, coercive ethical frameworks based on virtues or obedience to religious doctrine have largely been replaced by ethical systems that place more emphasis on individual rights. This raises the incommensurability question once again — are these different ethical perspectives mutually exclusive?

Conclusions

After exploring the nature of historical developments in AOKs other than the natural sciences, what can we conclude? We have not been able to apply the paradigm shift model exactly as formulated by Kuhn to the examples in other AOKs, which is not surprising, as Kuhn devised his theory about scientific revolutions by examining historical examples within the natural sciences. The examples discussed deviate from Kuhn's formulation in several ways.

In the human sciences, many of the things that people do resemble the work of natural scientists, but the human element in the human sciences makes it difficult to control variables and establish absolute truth, and some people dismiss the human sciences on that basis. Nonetheless, if we take them for what they are (rather than what natural scientists might want them to be) then there are examples of fundamental shifts in thinking in this AOK. However, these seldom involve a complete displacement of prior knowledge, different ideas instead tending to come in and out of favour.

In ethics, we must acknowledge the changing social context. Even if it is difficult to argue that ethical developments lead to absolute truth, ethics nonetheless makes progress in what it can achieve in society. As novel problems arise, ethics proposes new solutions. As we see changes in what is possible, we must revisit our thinking about what is desirable or morally right. Although the existence of ethics as a means of helping us behave socially has not changed, we might argue that the basis of ethical decision making has changed substantially as human horizons have broadened.

In both AOKs the historical developments seem less likely to undergo paradigm shifts in the purely Kuhnian sense, as the changes are rarely incommensurable. The difficulty in establishing absolute truth in these AOKs makes it less likely that one theory entirely replaces another.

Nonetheless, the examples above show that the stages of a Kuhnian scientific revolution (perhaps better labelled here a *knowledge revolution*) and some of Kuhn's vocabulary can offer insights into the historical development of knowledge more generally, and not just in the natural sciences, even if the strict definitions employed by Kuhn cannot be applied.

References and resources

Kitcher, P. (2011) *The Ethical Project*, Harvard University Press.

Kuhn, T. S. (2012) *The Structure of Scientific Revolutions: 50th Anniversary Edition*, University of Chicago Press.

McLeod, S. (2011) 'What is Psychology?', *Simply Psychology*, **www.tinyurl.com/7fj37ug**

Rosenberg, A. (1998) 'If Economics Isn't Science, What Is It?' in E. D. Klemke, R. Hollinger and D. W. Rudge (eds) *Introductory Readings in the Philosophy of Science* (3rd edn), Prometheus Books.

Wilson, T. D. (2012) 'Stop bullying the "soft" sciences', *Los Angeles Times*, **www.tinyurl.com/ydcmz96f**

Chris Coates is head of science and teaches TOK at Tanglin Trust School, Singapore. He is the co-author of *Chemistry for the IB Diploma* (www.hoddereducation.co.uk).

Glossary

Paradigm A way of thinking or well-accepted theory. Thomas Kuhn used the term to describe a scientific framework, accepted by consensus.

Scientific revolution The process of overturning one paradigm and replacing it with another.

Questions and activities

1 Several AOKs have been discussed, but there are others. What might a paradigm shift in mathematics look like? Would it be possible?

2 By definition, historical study places us at a distance from historical events and people. Perhaps historical thinking in one era is unavoidably incommensurable with that in another. What might represent a paradigm shift in the study of history?

No consensus

Why has it been so difficult to establish a consensus paradigm in psychology? Those who oppose awarding psychology the status of a paradigmatic science claim that the data obtained in many psychological studies cannot be adequately quantified. For example, studies often rely on self-reported data (such as measures of 'happiness'), therefore they lack the claim to objective truth that, say, physics possesses. The ability to choose one's own system of measurement makes it difficult to reach a consensus, and hence there is no established paradigm.

Some psychologists disagree (e.g. Wilson 2012), stating that psychological research leads to therapies that have been proven to work in randomised clinical trials, so the models at work are as valid, and crucially, predictive, as those in other areas of science.

If we look at what psychologists actually do, we observe striking similarities with revolutions in the natural sciences:

- old theories undergo crises and are challenged by new ones
- practitioners are personally invested in old or new theories, much as they are in the natural sciences
- old theories fall into disuse

Most importantly, psychology is generally accepted as a meaningful field of study that is used to solve problems. However, in the natural sciences, paradigm shifts have led to a closer agreement with actual objective truth (the Earth *does* orbit the Sun, matter *is* made of atoms). In psychology it is more difficult to make such a claim, although in the experimental branches of the subject the reproducibility and predictability of data certainly strengthen the claim to objectivity. There presumably are objectively real mechanisms by which the brain operates, even if they have not yet been established beyond doubt.

Economics

Economics also resembles a natural science. It is concerned with models, laws and theories, and it uses data. Rosenberg (1998) claims that economic theories are sufficiently robust to make causal claims. Also, economists seem to share a consensus on the underlying assumptions of their subject, such as the idea of utility as a measurable property, the desirability of growth, and the rational behaviour of populations. All this suggests that economics is indeed paradigmatic. If so, what does this paradigm look like?

Keynesian vs monetarist

After the Second World War the macroeconomic theories of John Maynard Keynes became popular all over the world. Keynes' emphasis on government spending, especially welfare programmes and universal healthcare, was well received by populations exhausted after years of war. However, by the 1970s, economic phenomena such as stagflation (high inflation combined with high unemployment) emerged, which were not easily explained using Keynesian theory.

After the late 1970s, monetarist economics gained influence, exemplified by the politics of Ronald Reagan and Margaret Thatcher, with countries manipulating their economies by controlling government spending rather than through taxation. Does this change in the prevailing economic thinking count as a full-blown paradigm shift? There are some parallels with the features of a paradigm shift as proposed by Kuhn:

- Both theories (Keynesianism and monetarism) were widely accepted in their respective eras. There was essentially a consensus in each case.
- The difficulties experienced by governments worldwide after the oil shocks of the early 1970s created a crisis that Keynesian economic thinking could not solve. Monetarism seemed more able to explain the crisis and offer a way out of it.
- The economic ideas in use were not merely a product of economists working in isolation. Instead the prevailing social and political context was extremely important in leading to the acceptance of the new economic theories.

On the other hand, paradigm shifts in science eventually lead to one prevailing new consensus, with no credible adherence to the old paradigm. In economics, previous models of economic thought remain available and have their proponents. Ideas go in and out of favour in economics, and different schools of economics can coexist simultaneously. For example, Keynesian economics had a resurgence after the financial crisis of 2008, whereas we would be unlikely to re-adopt ideas from outdated scientific paradigms.

Perhaps if we zoom out a little we might propose a third view. The different economic schools might be the equivalent of the discussion, argument and experiment that take place during what Kuhn calls 'normal science'. In other words, scientists (or economists) don't necessarily agree on everything, but they do adopt a shared worldview. In economics, the opposing theories both rely on a basic set of assumptions. What they do not agree on is how certain outcomes might be achieved.

Behavioural economics

A competing paradigm might be **behavioural economics**, which marks a more fundamental shift in perspective by denying that economies are driven by pure rationality but instead require consideration of sociological theories of behaviour. As behavioural economics becomes more widespread in its application, and demonstrates problem-solving ability, it may eventually become the dominant paradigm.

Ethical revolutions

In the discussion of developments in the human sciences, we asked whether a new theory:

- makes a more plausible claim to objective truth
- enables problems to be solved more effectively

In a scientific revolution such as the geocentrism–heliocentrism shift, the answer to both questions is yes. The revolution leads to a new phase of problem solving within the new paradigm. This is what we call 'progress' within the natural sciences.

GROUP 6: FILM

Approaching the external assessments

Breen O'Reilly advises on how to successfully plan for and execute the textual analysis and the comparative study

Next

Natalie Portman in *Black Swan* (2010)

If you are currently in your first year of IBDP film, you are among the first to experience the new film course. You will perform external assessments that are very different from those that previous students experienced. You do not have the luxury of learning from exemplars, so this article will provide you with approaches to the external assessments in reading film (the textual analysis) and contextualising film (the comparative study).

The textual analysis

The textual analysis is an essay with visuals and a list of all sources used. Your task is to show your knowledge and understanding of how meaning is constructed through the use of film elements.

Your first step should be to select a film segment that allows you to focus on the use of film elements. Remember that the extract you select (up to 5 minutes in length) does not have to be a single scene

and there are many advantages to including two scenes in your choice, as this allows for comment on transitions, contrasts and changes in lighting, mood, setting etc.

The textual analysis is marked against three criteria: cultural context, film elements and relationship to the film as a whole. These three areas are not equally weighted, with 12 points for film elements and 6 points each for the other two categories. Consequently, the biggest focus in your essay should be on the use and effects of film language.

You are also expected to link the film to its cultural context, and this will require research. The top mark band in the assessment criteria states, 'The student references suitable sources that are both relevant and appropriate.' Citing IMDB and Rotten Tomatoes should be avoided. Use academic websites — this custom search engine is a good starting point: **http://bit.ly/2se9LRB**. Filmsite.org also has excellent material on the cultural and historical context of films.

In addition, you need to link the extract to the film as a whole. This is where you can again discuss how the film elements in your extract are used in similar or contrasting ways. For example, a discussion of lighting in the opening 5 minutes of *The Godfather* allows for comparison of how and why the indoor and outdoor worlds are lit differently. This allows for links to other parts of the film, where lighting plays a key role in creating meaning. Check out the following YouTube channels for detailed textual analysis: Nerdwriter2, Every Frame a Painting, Lessons from the Screenplay. Any screenshots that you include must clearly support your written content and must not be added as eye candy.

Your teacher will give you three to five films from which to choose and you will have 1 month to complete the essay, which should be written in an academic tone using subject-specific terminology.

The comparative study

Your first step in preparing for a successful comparative study is to pick a suitable topic. It should be a well-formulated question, similar to a thesis statement in a written essay. Spend time revising, improving and refocusing your topic to ensure that the topic area is specific enough to ensure success.

For this assessment, you will create a video essay up to 10 minutes in length. There is no minimum time limit, but films that are significantly shorter than 10 minutes are unlikely to score well. Although film elements are not specifically mentioned in the preamble to this assessment task, it should be understood that most students will discuss these in the analysis of the two films and in articulating how they compare and contrast. Remember that 'the primary weight of audio-visual evidence must come from the two chosen films and the student's recorded voice'.

One of the biggest challenges will be to consistently reference sources throughout the comparative study. As this is a research task it is imperative that academic honesty practices are adhered to. Think about possible methods of citing on screen at the point of reference,

Theory of knowledge

1 To what extent is a comparative study a presentation of truth?
2 What choices by the filmmaker can influence perception?
3 'In the comparative study, you use film language to evaluate the use of film language and in doing so you use the terminology (language) of film analysis.' Discuss the meaning of the word 'language' in the above sentence.

Year 1 of this course should provide you with a broad understanding of the landscape of film, to enable you to identify areas of interest and awareness of genres, movements and theories that have dominated the field. This could be viewed as a subway map of film, and can help you identify specific stops along the way that you may wish to explore in more depth through your comparative study.

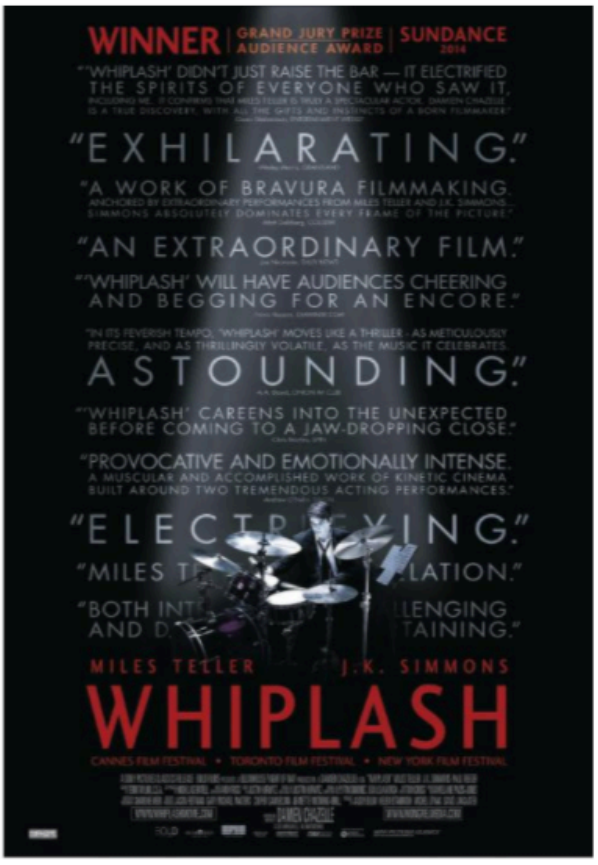
Whiplash vs *Black Swan*

Let's look at an example of an excellent video essay comparing these two films: *'Whiplash* vs *Black Swan'* (**www.tinyurl.com/ybgeh3dl**)

This video essay has many strengths from which to learn, but be aware that this is a video, not an IB comparative study. It does not meet all the criteria required to score well as a film student.

Let's look at the strengths:

- The narration is well paced — you must narrate your own comparative study, so learn from Michael. Don't speak too quickly or too slowly, and remember that you cannot appear in your comparative study. Make sure that the sound in each clip is low enough so that every word you say is clearly audible.
- The video does not waste time retelling the plot — you must assume the examiner knows the films you are comparing but not at the same depth as you, since you have researched deeply into your film. Watch the final 2 minutes of *'Whiplash* vs *Black Swan'* for an excellent example of how much background to include. This would make a great opening to a comparative study.



Ryan Gosling in *Drive* (2011)

References and resources

The following video essays, while not comparative studies, are examples of excellent construction and technical skill:

'*Drive* — The Quadrant System', **www.tinyurl.com/hh7lg5o**

'Wes Anderson & Yasujiro Ozu: A Visual Essay', **www.tinyurl.com/y8gytawv**

'Kurosawa and Ozu: Two Faces of Japanese Cinema', **www.tinyurl.com/ybgkhdwz**

■ Consider how the video does not separate analysis of each film into blocks but weaves the two together and often uses split screen to draw attention to similarities. The use of onscreen text is also very effective.

So what's missing? This would not make a successful comparative study without several additions. For a start, there are no on-screen citations. Citations need to appear at the time they are used in the comparative study. You may decide to use a direct quote or to paraphrase from your research. You should have a way to clearly signal whether you are quoting or paraphrasing. One way of doing this is to clearly show a Q (quote) or P (paraphrase) next to the onscreen citation. Another option is to include a video clip of an interview with an expert (critic, cinematographer, director etc.). However, this choice needs to be balanced with the requirement that the student's voice dominates the comparative study. Consider including interviews as quotes or paraphrases that are spoken in your own voice. To score in the top mark band, you are expected to analyse the cultural context of the selected films.

Backwards engineering

Now let's backwards-engineer '*Whiplash* vs *Black Swan*' to see how best to begin the assessment. Tables 1–3 show the process.

Step 1: area of film focus

Start by picking an area of film focus such as a film genre, film movement or film theory. By choosing formalism, this allows for examination of how film elements/language are used to create meaning in the selected films.

Step 2: cultural context

The topic will need to allow discussion of the characteristics of each film and the connections to the cultural context. '*Whiplash* vs *Black Swan*' does a great job on the first part but misses out on cultural context.

Table 1 Choosing formalism as your area of focus

Area of film focus	Focused topic	Two films
Film theory: formalism	The representation of obsession through film elements	*Whiplash* *Black Swan*

Table 2 Begin by choosing the area of film focus

Area of film focus	Focused topic	Two films
Film theory: Soviet montage	The enduring influence of Dziga Vertov	*Man with a Movie Camera* *Inception*

Table 3 Selecting from different historial periods

Area of film focus	Focused topic	Two films
Film movement: German expressionism	The representation of social outcasts	*The Cabinet of Dr. Caligari* *Edward Scissorhands*

Step 3: choosing the films

Next you need to select two films. Remember the important requirement here: at least one or both of the selected films must be from a time and/or place unfamiliar to you. So it is unlikely that you would actually choose *Whiplash* and *Black Swan*.

You may be tempted to start by choosing two films for comparison, but it is a better strategy to begin with the area of film focus, then the focused topic and finally the two films.

Assembling the essay

Now let's look at another example of an excellent video essay: 'Between the lines — *Inception* and the surreal' (**www.tinyurl.com/ybwffv6h**).

Unlike the comparative essay, this video covers several films. Hit the play button and immediately turn off your screen. Listen to the first minute or two and try to predict what images are on screen. There should be a strong correlation between the narration and the images. Listen for key words in the narration, and the images should match. When you write your own script, highlight the key words and build your visuals around these words.

Let's start by clarifying the expectations for the completed video. The highest mark band states:

> The comparative study is logical and effectively organized, conveying information audibly and in a visually appropriate manner. It is substantiated by relevant and meaningful visuals and examples that are effectively and explicitly linked to the topic being discussed. The work is consistently and effectively supported with accurate subject-specific terminology.

Create a relevant title sequence and end credits. You may want to create two versions of your comparative study, with one being anonymous and not including your name or school. The anonymised version will be submitted to the IB for assessment.

Plan how you will transition between clips and devise a consistent way of doing this throughout the film — fading to black has a professional look. Decide on how you will cite the use of resources on screen. Again, this should be done in a consistent manner. Ensure the sound from your clips does not interfere with your narration. Ensure that the narration volume is consistent throughout. Will you use onscreen text? If so, carefully pick your font type, size and colour. Whatever you decide, be consistent with its use throughout the comparative study.

Your comparative study will be submitted to the IB as one video file and one PDF of the list of sources. After reading this article you will be able to kick-start your comparative study and textual analysis and hone both assessments into impressive final products.

Key points

- While there are many excellent video essays available online, they do not meet the requirements for a comparative study.
- You are narrator of your comparative study. You cannot use a friend to narrate and you cannot appear in your video.
- Be aware of where your focus lies in your textual analysis. The evaluation of the effects of film elements is weighted at 50% of the assessed content. The other 50% is shared between cultural context and links to the film as a whole.

Breen O'Reilly teaches film in Beijing and is a principal examiner for IBDP film. He has published work on American crime film and music in film.

Although the monster is male, he is isolated and impoverished like the female characters

Next

Chiastic structure in *Frankenstein*

Few literary characters enjoy a larger life outside the pages of their original texts than Frankenstein's monster. Mary Shelley could never have known that her 'hideous progeny' would turn into a pop icon. The novel's structure rings with an even greater truth

Exam context

You can read Mary Shelley's *Frankenstein* in English language A: literature for part 4 (options).

More familiar as a movie image than he is from the novel conceived by the young Mary Shelley for a ghost story contest among friends in the summer of 1816, Frankenstein's monster has assumed a life of his own as a metaphor for overreaching. The novel is well suited for study under many different lenses, but a study of the structure connects many of the other approaches, offering a wealth of insight into the text.

Chiastic structure

Chiastic structure, also called **circle** or **ring structure**, is an ancient literary **frame device**, found in Homer's *Odyssey* and in numerous biblical narratives. It is defined by its mirror or repeated parts with a pivotal centre portion, depicted for clarity as A1-B1-C-B2-A2 (Figure 1).

This structure amplifies themes by contrasting narratives in the outer rings to cast light on the central narrative. Using a chiastic frame embedded with concentric accounts by Victor Frankenstein and his monster, Shelley crafts story within story within story. The outer narratives tell of Victor Frankenstein meeting an ambitious explorer searching for the North Pole and passage.

The central narrative, and thus the most important one, is of the nameless monster. The effect of this chiastic **construction**, amplified with parallel scenarios and **foil characters**, leaves little doubt of

Figure 1 Chiastic structure

authorial intent. Two of the narratives offer a scathing commentary of the **Romantic hero** — whether adventurer, scientist, scholar or artist. Outside of the context of community, the hero loses moral perspective and commits **hubris**.

Ironically, this most popularly known plotline is secondary to the central narrative of the monster, whose only overreaching is to wish to be human and be treated as family. Victor's rejection of his creation and the monster's angry and violent response bear implications for women in Shelley's time who were seeking equality in public and private life. Shelley was the daughter of the early feminist Mary Wollstonecraft.

Circle A1: Walton's letters

The novel begins with letters from explorer Robert Walton to his sister that set the stage for Victor Frankenstein. Walton mounts an expedition to the North Pole to discover an Eden where 'the sun is forever visible…and diffusing a perpetual splendor' and which is 'surpassing in wonders and in beauty every region hitherto discovered on the habitable globe'. By discovering a passage through the ice, he desires to bring 'inestimable benefit…on all mankind to the last generation'. Walton is a man of great ambition and naivety, who 'bitterly feel[s] the want of a friend'.

The expedition outfits in Archangel, a location with overtones of duality that are central to the narrative. In the Bible, Lucifer was an archangel who overreached and was cast out, and Walton's declaration 'what can stop the determined heart and resolved will of man?' echoes that hubris. The fourth letter introduces the discovery of a lone traveller across the ice, rescued from destruction by Walton and his crew. This 'interesting creature' with an 'expression of wildness, even of madness' is none other than Victor Frankenstein.

Finding a 'brother of the heart' in Victor, Walton confesses his ambition for discovery, claiming that 'one man's life or death were but a small price to pay for the acquirement of knowledge which I sought for the dominion I should acquire and transmit'. At this admission, Shelley provides the context for Victor to tell his 'strange and harrowing…story'. Thus, with Walton's ambitious willingness to sacrifice all to gain knowledge, the reader is primed for the second layer of narrative.

Circle B1: Victor's story

Chapters 1–10

Victor is the beloved son of doting parents, who falls in love with the natural sciences while studying at university. Fascinated with the occult as a child, Victor studies alchemy and then chemistry to access the secret of life, especially after the tragic and early death of his mother. In order to uncover that mystery, however, he must study death — and does so by creating a new human out of parts from the dead. After long months of isolation devoted to his task 'that [he] among so many men of genius…alone should be reserved to discover so astonishing a secret', Victor brings it to life, but promptly rejects his creation because it is hideously ugly.

Shelley's language for Victor's quest to defy the natural order of life and death is profoundly disturbing and creates an intersection of her two themes. He wants to 'penetrate into the recesses of nature, and show how she works in her hiding places'. Using words associated with procreation and childbirth, Victor describes the process as 'painful labour', 'the summit of my desires', and 'a gratifying consummation'. Like an unmarried mother (taboo at that time) Victor 'shunned his fellow creatures as if I had been guilty of a crime'. In a creation process that takes around 9 months, Victor usurps female generativity as both mother and father to bring forth 'a new species [who] would bless [him] as its creator and source'. Thus, in Victor's new world order, women would be superfluous. Sadly, however, Victor is not a 'protective spirit' like his father or mother.

In Victor's narrative, women are helpless, subject to the men around them, and thus not able to live up to their full humanity. Victor's mother, Caroline Beaufort, is isolated by her father's financial ruin only to be rescued by Victor's father. His foster sister and later fiancee, the orphan Elizabeth Lavenza, is rescued by Caroline from a life of poverty with Italian peasants. Presented to Victor as a gift, Victor regards her as 'a possession of my own' and as his 'more than sister'. Justine Moritz, a family servant, is persecuted by her mother after the death of her father and finds refuge with the Frankensteins.

Mary Shelley could never have known that her 'hideous progeny' would turn into a pop icon

In a creation process that takes around 9 months, Frankenstein usurps female generativity as both mother and father

When Victor's brother William is murdered, she is accused because she cannot account for her whereabouts and had a locket that had been in the dead child's possession.

Justine's execution underscores her victim status, exacerbated by the involvement of Victor and his monster. Justine has no alibi during the manhunt for the missing William because, rather than disturb family friends, she sought refuge in a barn as the night advanced. The monster, the actual murderer of William, plants the locket in her pocket as she sleeps. Although the monster falsely implicates Justine, Victor's silence condemns her to the gallows when he fails to come forward with the truth

Victor's first narrative ends with the confrontation with the monster, 6 years after its creation, and in the wake of William's murder and Justine's execution. Speaking for the first time to his creation, Victor calls his creature 'devil' and 'fiend'. In contrast, the monster is logical and calm, asking only to be heard. Imploring Victor for care and concern, the monster admonishes him, in an ironic twist from Victor's initial claims of glory as creator, claiming 'I ought to be thy Adam, but I am rather thy fallen angel, whom thou drivest from joy for no misdeed'.

Inner Circle C: the monster's tale

Chapters 11–17

In the previous two circles men aspire to be greater than they are, but women cannot live up to their full human potential. In between falls the monster. Although he is a male, he is isolated and impoverished like the female characters. His sole desire is to be a member of the human family. Isolated from family and community, however, he becomes a murderous menace — another warning to the Romantic hero. His narrative, embedded in Victor's, begins with his early sensory memories — cold, fear, hunger and loneliness.

Like Victor, his early delights were in nature. Self-taught like Walton, he discovers fire and seeks shelter. Villagers are repelled by his appearance, but he finds shelter in a pig shed adjoining a cottage, where he sets up residence, echoing Justine's night in the barn. Learning vicariously through watching the villagers, the monster learns language. As he gains knowledge, the monster asks 'was man, indeed, at once so powerful, so virtuous, and magnificent, yet so vicious and so base?'.

Like Victor's narrative, the monster's story casts female characters as imperiled by the actions of the men. Safie is endangered by her father's unjust trial and his betrayal of his rescuer Felix, Agatha's brother. Agatha is then imprisoned along with her father because of Felix's assistance in Safie's father's escape. The monster identifies with their suffering and empathises with their injustice. In contrast to the female characters who are rescued because they are beautiful, the hideous monster is rejected because he is ugly. Even when he saves a child from drowning, he is attacked by townspeople and barely escapes. When little William rejects him for his ugliness, it is the final straw. Not allowed to fulfil his humanity, the monster becomes a destroyer, a foil and tool for Victor's destructive hubris.

Pleading with Victor to create him a companion, the monster contends that '[he] is malicious because he is miserable'. A mate would allow him to have a community, and live, if not 'happy...harmless' in the jungles of South America, a new Adam and Eve. He threatens the reluctant Victor that, if he does not agree, the monster 'will work at [his] destruction, nor finish until [he] desolate[s] [his] heart'. Victor promises to create a female if the monster will leave Europe forever.

Circle B2: Victor returns

Chapters 18–23

Victor's second narrative places him unwillingly in a female role he had sought to usurp earlier, but instead of power he finds helplessness. Victor again isolates himself from his family, but this time to try to keep them from harm. His attempt to create a female creature ends with him rending 'the thing' to pieces in front of the monster. Another female character falls victim, not even allowed to come to life. In retribution, the monster murders Victor's travelling companion and boyhood friend, framing Victor for the murder. Victor learns firsthand what Justine felt being unjustly accused, but his gender saves him from ultimate condemnation.

Glossary

Construction In this case, the use of a chiastic frame device as the structure of the narrative. The effect is for each narrative to amplify the themes of the other.

Ego In Freudian psychological theory, the ego mediates between the conscious and unconscious parts of the psyche. In common parlance, ego is equated with self-esteem or self-importance. In philosophy, the ego is synonymous with 'the self'.

Foil characters Named for the reflective materials used in Renaissance jewellery, a foil character is a mirror image (in terms of traits, same but opposite) of another character, thus shedding more 'light' on that character's development.

Frame device A story set within the framework of another story. Authors use this device to amplify themes and develop characters.

Hubris The Greek word for the sin of overreaching pride or ambition, that is, for aspiring for more than one is due or for wanting to be like or better than God or a god. Hubris is often the downfall for a tragic hero.

Romantic hero Literary archetype, popular in the nineteenth century, who rejects or is rejected by society and faces his trials alone. While superficially noble, these heroes exhibit a self-absorption that ironically leads them to be blind to their own failings and therefore they often end tragically.

Victor Frankenstein rejects his creation because it is hideously ugly

Victor's greatest loss comes on his wedding night as the monster strangles Elizabeth, fulfilling his promise to be with him on this most important night. Crazed with grief and under suspicion for two deaths, Victor is imprisoned by local authorities. Regaining sanity, he is ultimately cleared. Victor asks the authorities for help in pursuing the creature but is rejected. Enraged at this refusal, Victor becomes like his monster, vowing to go to the ends of the earth for revenge.

Outer Circle A2: Walton's Diary

Chapter 24–end

The narrative now returns to the present. Victor urges Walton to take up the quest to destroy the monster, but ironically warns him from pursuing his own curiosity further. Victor acknowledges that pride propelled him to hubris and ruin. Facing mutiny because of the danger of the mission, Walton is forced to quit his journey but feels a sense of personal injustice. In Victor's dying breaths, he admonishes Walton to 'seek tranquility and avoid ambition' although he had not been able to. As Victor dies, the monster appears, repentant but self-involved, much like Victor. He departs, to die on the ice alone, 'borne away by the waves, and lost in darkness and distance'.

The whole is greater than the sum?

The structure of *Frankenstein* highlights the interplay of gender roles, which creates fertile ground to pursue what it means to be a human. Walton, Victor and later the monster burn with ambition. This ambition ultimately cuts them off from the moral compass of community, be it family, friends or crew. Their reasoning becomes flawed, one-sided, and lacking in objectivity, their actions increasingly motivated by the basest of emotions.

In addition, these male characters' actions damage the female characters, who are victims of circumstance, poverty and their gender. Because of the structure employed, the reader is in the privileged position of seeing the whole narrative as a linked series of stories, a structure that reveals a series of avoidable mistakes. Perhaps Shelley is asking us to find a middle ground, where ambition is realised, but not at any cost — a place where **ego**, or one's sense of importance, is contextualised within the whole.

Theory of knowledge

1 The monster recounts that his early memories are of sights and sounds, which only gained shape once he learned language. Explore the relationship between language and memory as ways of knowing.

2 The novel is often viewed as a cautionary tale about the dangers of scientific discovery. Explore the ethics of the life sciences. What is the basis of ethics in life sciences? Are there disagreements in how an ethical situation is to be determined?

3 The beginning of life is an issue hotly debated in political, religious, ethical and scientific realms. Explore on what basis each realm determines its stance. Are there commonalities? Where do they diverge?

Priscilla Biddle taught English A for 9 years prior to becoming the IB coordinator at Henrico High School, Virginia, USA.

IB ALUMNI

Jamie Bilbow

Celebrity chef

Jamie Bilbow is an established television presenter of cooking and travel shows in China. Jamie holds a degree in Chinese and is a qualified teacher of Chinese. He is a proficient chef, having received Michelin star tutelage, and has worked in restaurants in Hong Kong, China and London. He spoke to Paul Hoang about his time as an IB Diploma student

PH What are your memories of the IB Diploma?

JB I have fond memories of the IB. I suppose when I look back on my time in Sha Tin College in Hong Kong, most of my happiest memories are from the last 2 years. Despite the heavy workload, I found subjects suddenly became a lot more interesting and I felt myself becoming better equipped to handle the pressure. Looking back, I've probably never been better read in such a broad range of subjects than since the end of IB. From then on everything focuses on specialising but I couldn't be a bigger advocate for keeping things academically broad at such a crucial stage of development.

The diverse range of courses and flexibility within the Diploma really helped me, as I was able to choose food science and technology as a science subject and take business management instead of another humanities subject. These two subjects have gone on to have a big impact on my eventual career.

PH How did the IB prepare you for university?

JB Looking back, I was so well prepared for university — IB made me an organised and inquisitive learner. The responsibilities we were given during the IB Diploma were extremely useful. For instance, having to make sure we satisfied all the CAS requirements helped make us better-rounded students and TOK helped sharpen our way of approaching new knowledge. The IB made me an open-minded student with a global perspective, which became an important attribute when studying at the School of Oriental and African Studies (SOAS) in London. When I arrived at university, I felt the level of difficulty of my degree was well matched to the IB and I generally found the transition from IB to a BA Honours degree to be quite seamless.

PH Did you have a favourite subject or part of the IB?

JB I had three favourite subjects at school and I was lucky to be able to study them from year 7 right the way through to IB Diploma in years 12 and 13. My favourite subjects were drama, food technology and languages, and at IB I studied theatre arts HL and food science and technology and Spanish SL. It is no coincidence that my current profession as a television chef, presenting food shows in Chinese, is

a hybrid of these three subjects. Without a doubt, I would directly attribute what I have achieved in the past 6 years since finishing university to the foundation I developed during the IB.

PH How did you decide on what to study at university?

JB After being talked out of the idea of catering college in favour of a more academic route, I knew I wanted to do a degree in languages. I originally decided to do Spanish. However, after much thought I decided to do Mandarin and business management instead. Having lived in Asia since the age of 1, I felt it was important to study an Asian language, and Mandarin seemed to be the most logical choice.

PH How did this lead to your current profession?

JB While studying Chinese and business management at university, I worked in a number of restaurants to keep up my interest in cooking. After I finished studying at SOAS I moved out to Beijing and worked freelance for 3 and a half years, doing a number of different jobs that combined my love of languages, cooking and acting. I sold hummus from a tricycle, ran a cooking workshop teaching locals how to make foods from around the world, wrote a cookbook and went on a variety of gimmicky television shows before a Singaporean production company got in touch with an offer to present my own food and travel show on CCTV (China Central Television).

My first series, *The Wandering Chef's Adventure*, was shot in Yunnan and won Best Lifestyle Programme at the 20th Asian TV Awards. The second series, *Delicacy Hunter: On the Silk Road*, was broadcast in English on the Discovery Channel and in Chinese on CCTV 9 and a number of other platforms. In between filming these shows, I returned to the UK to do a PGCE (Post Graduate Certificate in Education) at the Institute of Education, University of London and graduated as a secondary school teacher of Mandarin. I have since moved back to Hong Kong where I am designing an extracurricular course providing Chinese language cooking classes for secondary school students. I am also planning two new television series to be filmed later this year.

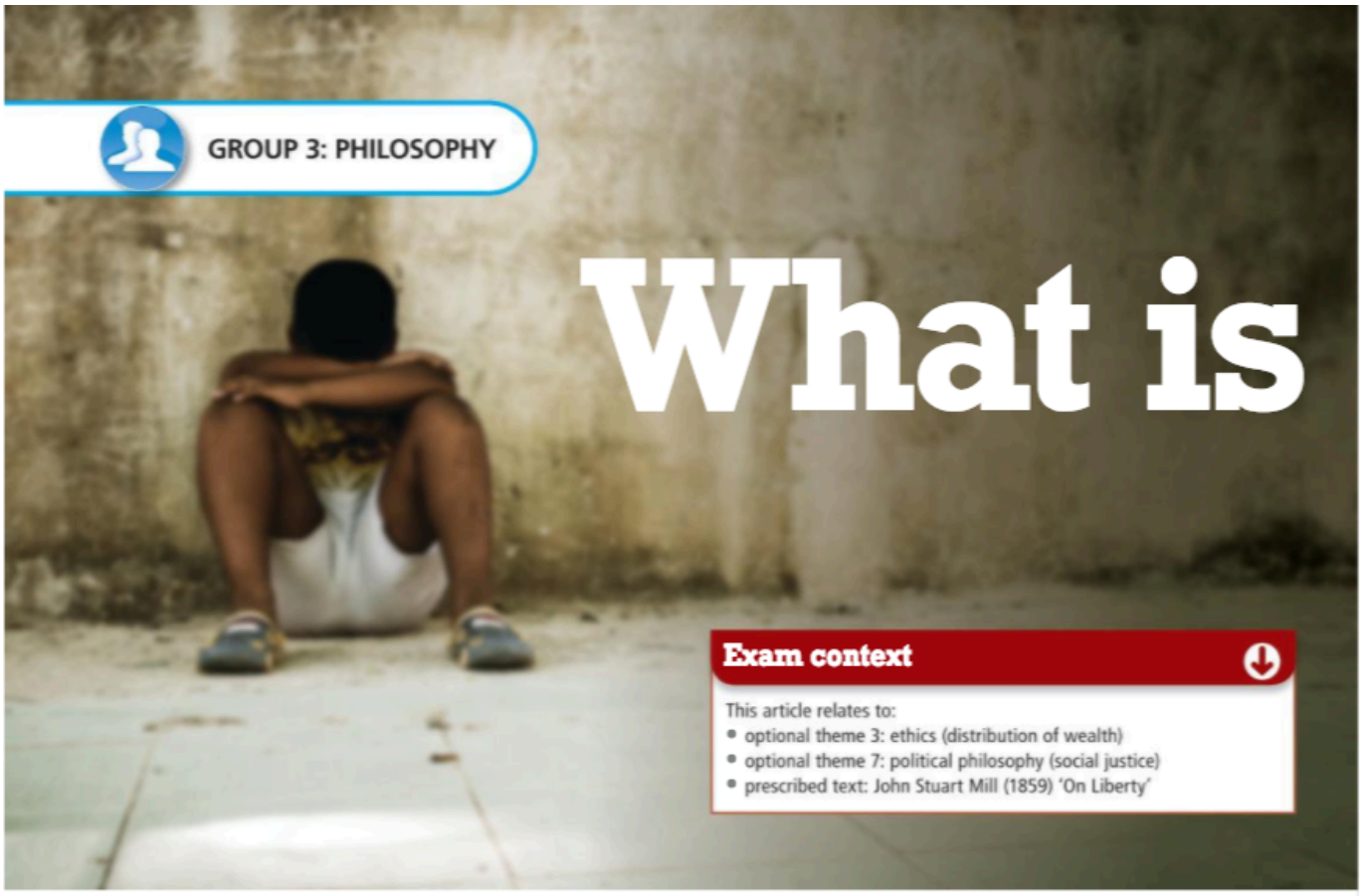
PH Which aspects of your job do you enjoy most?

JB I love being able to use my language to learn about different food cultures around China and share what I know about foods from around the world. I am a firm believer that the more people you are able to converse with, the more you stand to learn. I also enjoy showing people a side of China that isn't always shown in Western media, and finding out how everyday people go about their lives maintaining food traditions that have existed for centuries.

PH What advice do you have for IB students?

JB I have worked on so many different 'projects' that, pieced together, have become my career. My advice would be to make sure you focus on collecting skills and life experiences as much as you can over the next 5 to 10 years. A job can be taken away but skills and experience can't, so train yourself well and try to say 'yes' to as many opportunities as you can. I can only speak for myself, but I looked at the three subjects I enjoyed most and was best at during IB: theatre, food and languages. I chose an academic route to make sure I had a solid foundation and kept improving my cooking and acting skills outside of my degree. Once I graduated, I put myself in a place where my skills were most relevant and with a bit of luck, some good timing and a lot of persistence, I am now happy to say I have my dream job. I hope students reading this article can take inspiration and hopefully find their own unique path otherwise known as a 'career'.

The first series of Jamie's show is available at **www.tinyurl.com/chef-adventure**



GROUP 3: PHILOSOPHY

What is

Exam context

This article relates to:
- optional theme 3: ethics (distribution of wealth)
- optional theme 7: political philosophy (social justice)
- prescribed text: John Stuart Mill (1859) 'On Liberty'

The ancient Greek philosopher Plato reflected that 'justice in the life and conduct of the State is possible only if first it resides in the hearts and souls of the citizens'. Plato's *Republic* develops as a **Socratic dialogue** regarding the nature of justice in terms of giving people what they deserve. How this is done or how it should be done is unclear. For Plato, justice was ascertainable if the pursuit of the perfect form of justice allows us to escape from the 'world of shadows' (the material world) and our souls recollect the 'world of forms' (the perfect immaterial and unchanging realm).

Social justice

Plato's quote at its core suggests a profound significance regarding the more practical connection between the role of citizenship and the state, i.e. it should be participatory. Furthermore, the community has a reciprocal relationship with the values of the state and one cannot function to its optimum unless it is mirrored by the other. Current forms of governance, including **representative democracy**, are arguably far less immersive than the concepts of citizenship that Plato outlined. Voting in elections and referendums does not necessarily require each voter to engage fully with the issues but rather place one candidate or view ahead of the other based on the 'facts' as they are presented.

Linguist and philosopher Noam Chomsky's 2015 documentary *Requiem for the American Dream* examined the relationship between the state and the people within a democracy. Chomsky highlights Aristotelian concepts of democracy, which suggest that in order to maintain a functioning democracy it is essential to reduce inequality, as this produces resentment between classes within society. To some extent, this delicate balance is maintained by the concept of social justice.

Chomsky asserts that in American representative democracy, inequality has grown and there has been a *reduction* in democracy. In August 2016 CNN reported that the richest 10% hold 76% of the USA's wealth. Furthermore, the World Economic Forum reported in January 2017 that the richest people in the world have the same wealth as the poorest 3.5 billion. In what could be interpreted as a vindication of Chomsky's view, the USA Freedom Act was passed in 2015. Many commentators believed this was an acknowledgement that the freedoms of American citizens had been violated in the form of anti-democratic monitoring by the National Security Agency (NSA). This analysis could prove provocative in the era of the Trump administration.

Emperor's new clothes?

Social justice can be seen as a politicised term. Twentieth-century political economist Friedrich Hayek suggested in his book *Law, Legislation and Liberty* that he had come to terms with social justice being a mirage, as it is never clearly defined and therefore of little practical use or substance. He likened such a mirage to the Hans Christian Andersen story of the emperor's new clothes, i.e. an idea without substance and an important concept reduced to a soundbite. Global politicians from the full range of the political spectrum promote some concept of social justice, yet Philippine president Rodrigo Duterte's view of this term is in stark contrast to German chancellor Angela Merkel's definition. Hayek argued that no individual (or any

justice?

Sian May outlines the different philosophical interpretations of justice

committee or political party) can design rules that would treat each person according to their merits or even their needs.

Harvard philosopher Michael Sandel suggests that:

> 'To argue about justice is unavoidably to argue about virtues, about substantive moral and even spiritual questions.'

Sandel seeks to motivate a reenergising of modern perceptions of the individual in relation to the state. He advocates a fresh analysis of this relationship in order to solve new and evolving problems.

However, one criticism is that such debates are mere abstractions and do little to impact the world in any meaningful and practical sense. For Hayek, economic markets operating without state intervention could only guarantee individual liberty, not a notion of social justice or democracy. State intervention in such economic mechanisms was, according to Hayek, the 'road to serfdom.' He would be opposed to methods such as **quantitative easing**, for example, which has been used widely by a number of governments, including in the UK, China and the USA.

Justice as fairness?

Twentieth-century philosopher John Rawls put forward the idea, in contrast to Hayek, of 'justice as fairness', suggesting this is the only definition that can be considered when building a society. In his theory of justice, Rawls argued that all citizens are free and equal and therefore society's mechanisms and institutions should promote fairness for all. He further argued that this was a superior idea due to its emphasis on **egalitarianism** rather than what he saw as the prevailing wisdom of utilitarianism (which sacrificed the minority), which dominated modern Western political thinking.

British philosopher John Stuart Mill proposed similar conceptions when he reformed Jeremy Bentham's formulation of utilitarianism and suggested that societies can be virtuous in similar ways to individual moral agents. Therefore, for both scholars, the structures of society are capable of being used as conduits for justice, as these institutions provide the parameters of the freedoms enjoyed by society, such as the education, legal and penal systems.

Twentieth-century philosopher Michael Novak disagreed with Rawls and Mill, and dismissed the idea that institutions are able to promote fairness, as that would be to attribute virtues to institutions that are essentially inanimate mechanisms of societal power rather than moral agents. Novak believed the view was outdated, as societies were becoming larger and perhaps less personalised in their ability to reflect communal virtues.

Preserving liberty

In the 1970s, as this debate raged, Australian philosopher Peter Singer reacted to American Robert Nozick's *Anarchy, State and Utopia* in several reviews and editorials. Nozick argued for a small state to ensure that no citizen had their liberty or rights violated by state interference. The meta-utopia he envisaged would provide

Questions and activities

1. Why do concepts of justice appear to be so culturally varied?
2. Is justice different depending on your gender?
3. Does wealth ensure justice?
4. How do we define justice without considering material wealth and economics? Does the concept of justice belong in politics?
5. Is justice ascertainable?
6. How do we define social justice?
7. Is justice compatible with democracy?
8. Is justice compatible with capitalism?
9. How do we preserve individual liberty when seeking some form of social justice?

Glossary

Egalitarianism The belief that all people are equal and deserve equal rights.

Food sovereignty Allows communities control over the way food is produced, traded and consumed.

Living wage A wage that is enough to live on, i.e. meets the basic needs of the worker.

Moral agency An individual's ability to choose right or wrong actions and be accountable for their decision making.

Quantitative easing The introduction of additional money into the money supply by a central bank.

Representative democracy Democracy founded on the principle of elected officials representing a group of people.

Socratic dialogue A formal discussion led by a facilitator when a small group addresses a key question of importance, e.g. 'what is justice?'

a framework for many diverse communal experiments, all formed by voluntary communities. Within a community, people may voluntarily adopt redistributive wealth measures for example, and those who do not wish to participate could leave, but within a nation there should be no compulsory redistribution.

Singer questioned whether such a community could survive if it required a lot of redistribution. He also pointed out that wealthy members might depart, possess differing moral principles and be motivated primarily by their desire for wealth. Singer raised important concerns regarding the practical issue of societal cohesion in the face of such challenges which still resonate today: how do we preserve individual liberty when seeking some form of social justice?

Dan Ariely, professor of psychology and behavioural economics, explores John Rawls' ideas on justice further in his TED talk 'How equal do we want the world to be?' Ariely interprets the concept of social justice as being related to wealth acquisition and distribution. Ariely's wide-ranging research included large-scale surveys in the USA and other countries that sought to discover what knowledge gaps exist in perceptions of wealth inequality. The results of the surveys revealed that what we have and what we think we have are different. For instance, in the USA those surveyed believed that the top 20% in terms of wealth in society controlled 58.5% of the wealth, whereas the reality was that the top 20% controlled 84.4% of the wealth. Therefore, a sizeable knowledge gap exists, which in order to close requires a more reflective educative approach. This knowledge gap can permeate the debate regarding social justice and prevent the required measures being supported by a given community, so must be addressed.

Veil of ignorance

John Rawls considered the 'veil of ignorance' to be the thought experiment that was most able to test whether a society was just. It asks whether if you knew everything about a society, including who controls what proportion of the wealth, would you still be willing to enter it at any level of society? Ariely calls this a 'blind tasting of outcomes'. During his research, nobody surveyed in the 'blind tasting' opted for complete egalitarianism/equality in terms of wealth distribution. Research indicated that the perception gap was between our estimated, ideal and actual understanding of wealth distribution. Respondents were not positive where the wealth inequality was perceived to be too great. Other indicators of economic distribution such as education, healthcare and life expectancy held even less appeal for respondents where there was a disparity (or perceived injustice) in access. Respondents were most sympathetic to those who had least **moral agency**, e.g. children.

However, Rawls' veil of ignorance is observed to reduce self interest in our

perceptions. Ariely further identifies an action gap in attaining social justice and advocates approaching economic distribution through children, as this is where most empathy was indicated by those who participated in the research.

In most academic circles, social justice appears to be synonymous with economic justice. Non-governmental organisations such as War on Want (established in the UK in 1952) were created in the belief that an international struggle against poverty was necessary to address social justice. In the twenty-first century, campaigns have been motivated by the desire for **food sovereignty** and the pursuit of a **living wage**, which War on Want believes are by-products of globalisation. War on Want's aims are to:

> work in partnership with progressive movements and other organisations in the global justice movement to build alternatives to a world economic system that has failed to deliver an equal distribution of wealth.

Rich and guilty

Black American human rights lawyer Bryan Stevenson has written at length about inequalities in the US legal system, which unfairly penalises black communities. In his book *Just Mercy* he explores injustices that are retrospectively overturned in the judicial system:

> My work with the poor and the incarcerated has persuaded me that the opposite of poverty is not wealth; the opposite of poverty is justice.

The USA has the highest rate of incarceration in the world, where poor communities are wrought with despair. The National Association for the Advancement of Colored People (NAACP) states that one in three black men in the USA are either in prison, on probation or on parole. Stevenson argues that the justice system is distorted by race and poverty:

> Rich and guilty rather than poor and innocent is favoured.

There are huge perception gaps in the public regarding this issue, which exacerbates the sense of injustice. In Alabama, 34% of black males have permanently lost the right to vote following criminal convictions. Stevenson questions how people in a democracy are able to engage with the issues and mechanisms of power if they are excluded from them. What of justice in a legal sense?

These ideas are further explored in the documentary *13th*, directed by Ava DuVernay. The documentary asserts that the black community has been criminalised in order to fuel a lucrative judicial system where the courts and prison, probation and parole services are often run by the same corporate providers, with an economic interest in ensuring that this polarisation continues. If such systemic gaps do exist along ethnic and racial lines, then the burden of the historical context of slavery still must impact on the economic mechanisms governing such forms of capitalism. According to the NAACP (whose aim is 'to ensure the political, educational, social, and economic equality of rights of all persons and to eliminate race-based discrimination') such disparities are self-evident. For example, according to NAACP statistics, as many white Americans use drugs as black Americans, yet black Americans are sent to prison for drug offences at ten times the rate of white Americans. Such findings demonstrate the difficulties involved in achieving justice for all.

Conclusions

Rawls' veil of ignorance calls upon all of us to extend our viewpoint beyond distinguishing characteristics such as race, ethnicity and gender. However, in the USA, which is frequently perceived to be a champion of democracy, such a gap exists. Therefore, perhaps the knowledge and action gaps Ariely's work refers to are the starting point. Self-reflection on a local, national and global scale appears to be necessary. This will continue to be a serious challenge in the future for world leaders and citizens. How do we know that current local, national and international discussions and actions are working? How do we know that those we elect are concerned with justice? Plato's view of citizenship was rooted in a democracy where each individual had to play an active and accountable role. As individuals, should we perhaps reflect on what our contribution will be in attaining justice for our own communities and the international community as a whole?

References and resources

Elliot, L. (2017) 'World's eight richest people have same wealth as poorest 50%', *Guardian*, **www.tinyurl.com/h23y48k**

Hayek, F. (1973) *Law, Legislation and Liberty*, Routledge.

Novak, M. (2000) 'Defining Social Justice', First Things, **www.tinyurl.com/y8y4krpa**

Nozick, R. (1974) *Anarchy, State and Utopia*, Basic.

Sahadi, J (2016) 'The richest 10% hold 76% of the wealth', CNN Money, **www.tinyurl.com/zctfm47**

Sian May is high school principal at the International School of Lausanne, Switzerland, where she teaches TOK and MYP.

Paradigm

In his book *The Structure of Scientific Revolutions* (1962) Thomas Kuhn claimed that scientific knowledge could be described as a series of scientific revolutions in which scientific paradigms, or ways of thinking, are entirely replaced by others. He called these revolutions *paradigm shifts* and suggested that they follow five phases

Phase 1: pre-paradigmatic state

The **pre-paradigmatic state** refers to a period before a scientific consensus has been reached. In modern science we have well-formulated theories in areas such as:

- the structure of the cosmos
- the evolution of organisms
- theories of disease and their treatment
- the chemical composition of matter

In ancient times there was no clear understanding of how such things worked and scientific experimentation did not yet exist. If humans believed anything about these elements of the natural world it was likely to be ascribed to a supernatural creator or addressed as a practical necessity, for example the use of certain herbs to treat ailments, gathered from experience.

Phase 2: normal science

Before modern science existed, many societies (for example in Greece and in the middle east) had an established class of natural philosophers who tried to understand the world. They developed theories that became widely accepted. A consensus was reached and a paradigm was established. New knowledge was incorporated into the paradigm.

Examples of early scientific paradigms are:

- **Geocentric view of the heavens**: the Sun and planets exist on a series of concentric spheres, centred on the Earth, which rotate, causing planetary motion.
- **Lamarckian evolution**: understood as a goal-oriented process in which organisms 'try' to adjust to their surroundings.
- **Humour theory of disease**: the body is filled with four substances called *humours*. Ill-health arises from an imbalance of these substances. Treatment is based on attempts to restore the balance, for example by bleeding the patient to remove excess blood.
- **Aristotelian physics**: objects move according to their 'nature'. If they are mostly made of 'earth' they will fall. If mostly composed of 'air' they will rise.

The paradigm provides natural philosophers with a way of thinking about a concept. They then work on the details and use the paradigm to rationalise more natural phenomena. Kuhn called this process of elaboration **normal science**.

Phase 3: crisis

The scientists engaged in normal science will make observations that cannot be easily explained. For example, simple geocentrism could not explain the 'wandering' of planets in their orbits.

Galileo also challenged Aristotelian physics when he devised a series of experiments into the motion of objects. Most famously he dropped two spheres of different weights from the leaning tower of Pisa and observed that they hit the ground at the same time. Aristotle had claimed that the heavier one should fall faster.

During the crisis, modifications may be proposed to allow the observations to fit. The geocentric model was adapted by the addition of epicycles – smaller rotating spheres upon the major spheres, which allowed the planetary wandering to be explained.

Is Kuhn's theory valid?

Kuhn has been accused of being a relativist. Maybe all the theories are equally valid? Why should we believe today's science when it might be overturned in future? Kuhn vigorously rejected this, claiming that scientific revolutions have always led to new, more accurate theories, and represent true progress.

However, each successive paradigm is the best available at the time and frequently older paradigms did make useful predictions. In its final stages, the geocentric paradigm, although complex and rather inelegant (spheres upon spheres upon spheres), did accurately describe planetary motion.

Perhaps in future we will have new theories in physics that will better explain and unify the worlds of quantum mechanics and relativity, but the theories as they stand today are predictive and useful. Science tries to describe the natural world as accurately as possible. Successive paradigms illustrate scientists' willingness to be proven wrong, and their commitment to objective truth in their endeavours.

shifts

Phase 4: revolution

This is where the paradigm shift occurs. Eventually the challenges to the paradigm become insurmountable. A number of competing theories may be proposed that seem to offer a better explanation. A 'tipping point' is reached, whereby the consensus view moves towards a new paradigm.

Examples of paradigm shifts include:

- The geocentric model was replaced with a **heliocentric model**, in which the planets are understood to orbit the Sun in elliptical orbits.
- Lamarckian evolution was replaced with Darwin's theory of **evolution by natural selection**. The long neck of the giraffe was explained not as a result of efforts by the giraffe to 'reach' for food in high trees, but instead as a process of gradual change in which those giraffes with longer necks were better able to survive until reproductive age.
- **Germ theory of disease**: sickness is caused not by an internal balance of humours but by external vectors — microorganisms transferred from person to person. Disease prevention should be focused on the prevention of transmission of these microorganisms.
- Einstein's paper on Brownian motion in 1905 proved that **matter consists of discrete particles**, and is not continuous.

It is important to remember that Kuhn does not see a paradigm shift as a mere choice between equally credible theories. A scientific revolution occurs when:

- the new paradigm is incommensurate with the old (you cannot simultaneously believe that the Earth is central to the heavens, and that the Sun is central)
- the new paradigm better explains the observations, and offers a model that is closer to the objective, external reality. Often, improved technology (e.g. telescopes, microscopes) helps confirms the model

Phase 5: return to normal science

Once the new paradigm has been established, normal science resumes. Newton formulated his laws of planetary motion assuming a heliocentric view. Thomson and Rutherford, among many others, developed the atomic model and demonstrated the existence of subatomic particles.

IBReview*Extras*

Download this poster at www.hoddereducation.co.uk/ibreviewextras

Chris Coates is head of science and teaches TOK at Tanglin Trust School, Singapore. He is the co-author of *Chemistry for the IB Diploma* (www.hoddereducation.co.uk).

EE EXTENDED ESSAY

Writing and reflection

John Cannings provides examples of the type of reflection that is required for the extended essay

The extended essay (EE) is extremely rewarding, as it allows you to research a topic that is of interest to you, and is challenging due of the nature of the research process. It is important to choose a topic that is of personal interest, as this helps motivation and perseverance with the task. Although the EE does not have to cover a subject that you are studying, few students who follow this path get high grades.

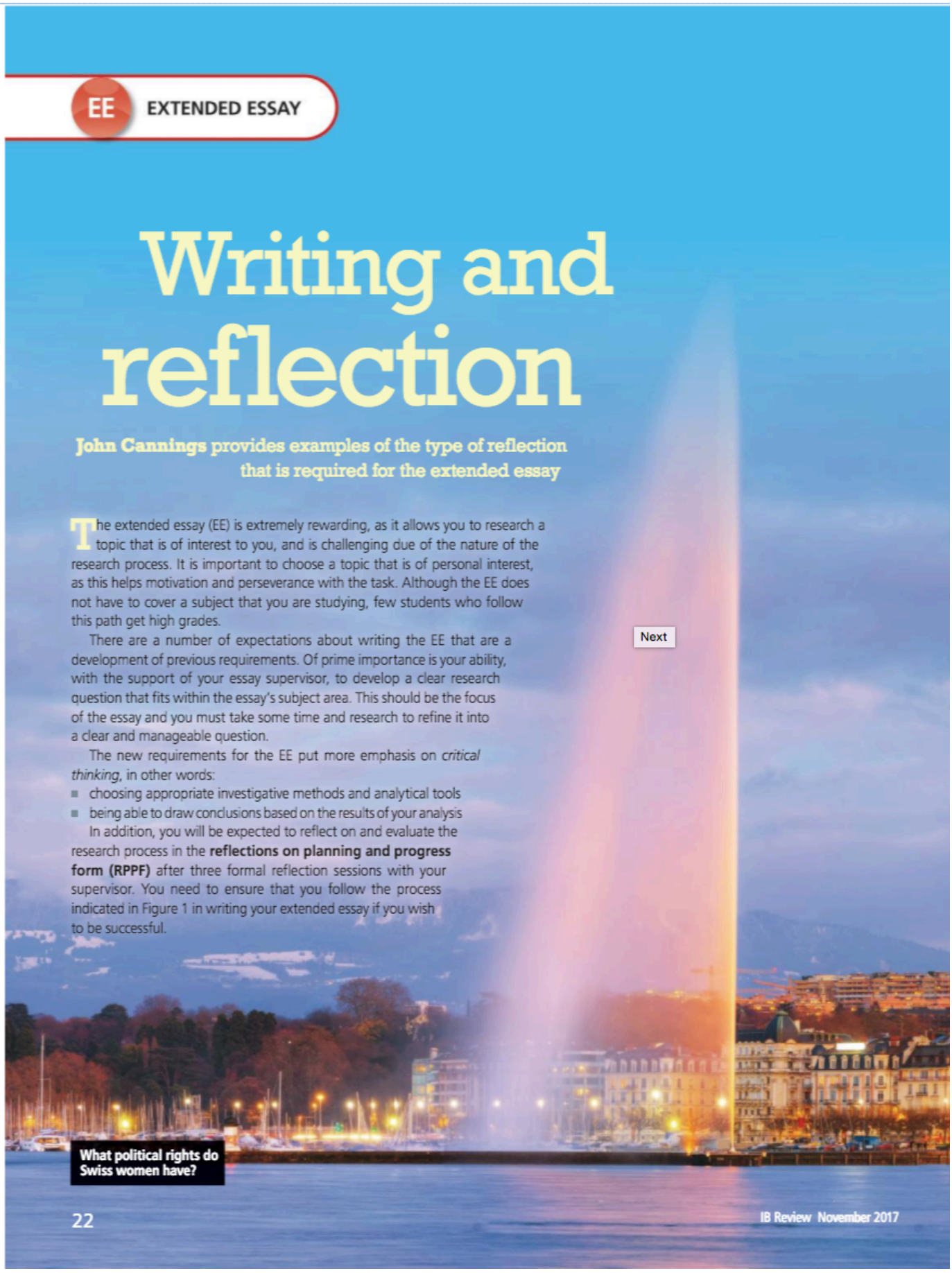
There are a number of expectations about writing the EE that are a development of previous requirements. Of prime importance is your ability, with the support of your essay supervisor, to develop a clear research question that fits within the essay's subject area. This should be the focus of the essay and you must take some time and research to refine it into a clear and manageable question.

The new requirements for the EE put more emphasis on *critical thinking*, in other words:

- choosing appropriate investigative methods and analytical tools
- being able to draw conclusions based on the results of your analysis

In addition, you will be expected to reflect on and evaluate the research process in the **reflections on planning and progress form (RPPF)** after three formal reflection sessions with your supervisor. You need to ensure that you follow the process indicated in Figure 1 in writing your extended essay if you wish to be successful.

Next



What political rights do Swiss women have?

Next

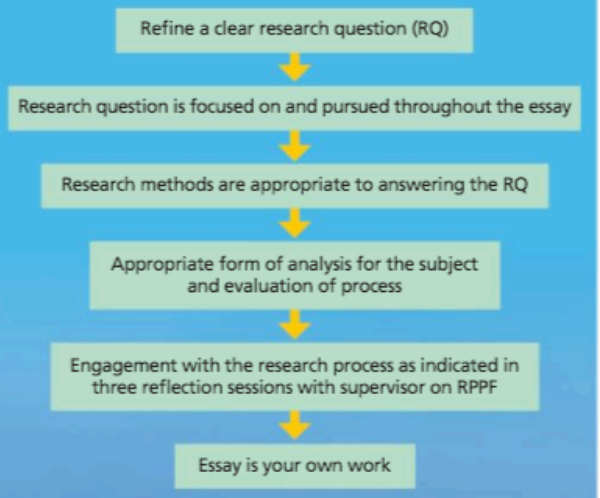


Figure 1 Process diagram for a successful extended essay

EE assessment criteria

There have been some significant changes in the weighting of marks recently, with much more emphasis on your ability to analyse and evaluate your own work than was the case in earlier versions of the extended essay. A summary of the mark allocations are found below:

Criterion A: focus and method (6 marks)

This criterion looks at how well your research question is focused and how that focus is sustained throughout the essay. It also considers the method of investigation.

Criterion B: knowledge and understanding (6 marks)

This criterion considers how well the research question relates to the discipline you are writing in. It also considers use of language and concepts of the discipline.

Criterion C: critical thinking (12 marks)

This criterion judges how well you have carried out the research, analysed findings and evaluated the process of research.

Criterion D: formal presentation of the essay (4 marks)

This criterion considers how well you have organised your essay, and whether you have followed the requirements for a formal piece of academic writing.

Criterion E: engagement with the research process (6 marks)

This criterion assesses the quality of your reflections about the research process on the RPPF.

Researcher's reflection space

The researcher's reflection space (RRS) can be in any format, such as your EE file in Managebac, on your own website or within a blog. In this space you should record the research process, possibly including questions that you have about your topic; investigative techniques; and books, articles and podcasts that you find useful. It should also include your notes and comments from the three reflection sessions. The RRS can be a valuable stimulus for the three compulsory reflection sessions.

Writing the essay

Choosing the topic

You should choose a topic that interests you from a subject that you are studying. The example essay that I have chosen is taken from the subject of geography. The topic focuses on gender issues in Switzerland and the status of women in financial institutions there, as women's status is part of the study on changing population that is a key part of the core of the geography course. The general topic selected by the student then becomes slowly refined as some research is done. The supervisor helps clarify their thoughts in discussions they have about the topic.

From topic to research question

Women's status in Switzerland

- What political rights do Swiss women have?
- What rights do Swiss women have to own land?
- What role do Swiss women play in the economy?
- What recognition is there for Swiss sportswomen?

Women in the Swiss economy

- What are the main occupations of women in the Swiss economy?
- How many Swiss women are executive members of Swiss companies?
- Are there legal requirements for equal opportunity employment policies?

Factors affecting Swiss women's economic status

- How does a woman's fertility affect her ability to be a member of a company's executive?
- How does a woman's marital status affect her ability to become a member of a company's executive?
- Potential research question: in what ways has a woman's fertilty affected her position in a Swiss financial company?

The first reflection session

This is your chance to demonstrate to your supervisor that some research has been undertaken. It is important that notes and thoughts collated about the topic are in the RRS for this meeting. You should prepare a short presentation for this and share your RRS with your supervisor.

In this meeting the supervisor should ask some questions about the suitability of the topic and make some suggestions about refining the research question and possible avenues of investigation. You must take some notes of this meeting (and the subsequent two meetings), then write your first reflection. Below is an example of a reflection that could be written on the essay topic of women's status in Swiss financial institutions:

> My supervisor thinks that I have found some interesting published data and information on the employment of female executives and the way that having a family may have influenced their career path. From my discussion with Frau Bruner at ZXY Bank, it looks as though very few women with

Zoom

large families make it to the top in Swiss companies. They tend to progress as far as middle management, but not to the executive level. I think this will be the focus of my research as I continue to read published materials to address my title question.

This first reflection should be around 100–150 words in length. After this first formal reflection session you should be ready to finalise your research question, if this hasn't been done beforehand.

Using your TOK skills

You can use your TOK skills to help plan and carry out the research for the process of writing the EE. Take the knowledge framework from TOK that is appropriate to the subject the essay is going to be written in and use it to help plan the research. Below is an example, using the knowledge framework for the human sciences (focusing specifically on geography):

Scope/application

The topic is definitely related to the study of geography. As a result of the research I hope to make a generalised statement about the factors affecting women's employment.

Language

The topic will be using language appropriate to geography. I shall be using key terms such as 'fertility'. I might also be using mathematical terms such as 'correlation' in this essay.

Methodology

I shall be using research methods appropriate for the human sciences by carrying out surveys and possibly interviews. A key issue that I might face is the size of my sample. I shall use statistical tests to see if correlations exist between variables.

Historical development

The use of published data from government sources will provide appropriate historical data. The use of questionnaires and interviews are techniques historically used in geography to obtain primary data.

Links to personal knowledge

I am interested in finding out how far women can progress in the financial industry. My mother has worked at a Swiss bank for 12 years.

Knowledge questions

How do we decide which questions are relevant to us being able to answer the research question?

Using your TOK skills should help clarify what you are trying to research and how to undertake the research.

The second reflection session

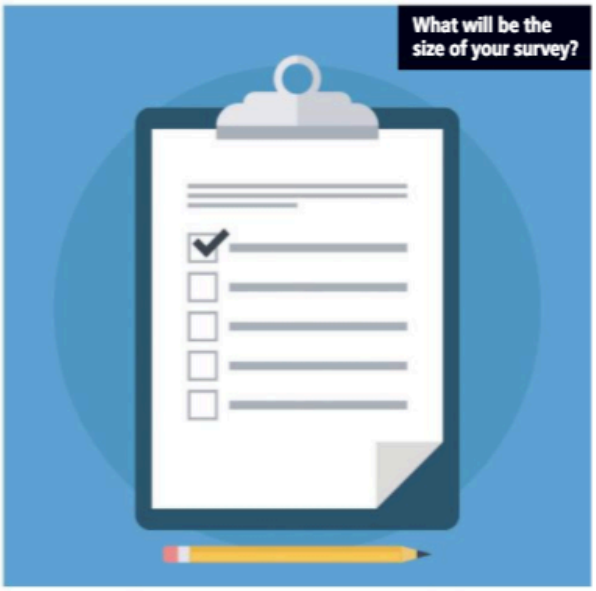
The preparation for this reflection session is important because you should be clearer about the following aspects:

- The final research question, e.g. in what ways does a woman's fertility affect her position in a Swiss bank?
- The context for the essay, e.g. a member of a Swiss bank has offered to allow the student to carry out interviews and surveys with employees. They are also able to access historical data showing the number of female executives in the Swiss bank over the past 10 years.

Research had been done on Swiss employment laws and regulations as preparation for this meeting:

The methodology of the research

- What published data can be used/collected?
- What will be the size of the survey?
- How will it be conducted?
- What type of questions will be asked — open/closed?
- How are the results of secondary and primary research to be analysed?
- How will the results be presented?



Timeline of the research and writing

- When will the secondary research process be completed?
- When will the surveys and interviews be carried out?
- When will the writing process be completed?

This reflection session should be a golden opportunity for you to clarify your thoughts and ensure that the research is heading in the right direction. Your supervisor may wish to look at your RRS and your bibliography to date.

It is imperative that you take some notes of the meeting and reflect again after the meeting. This reflection is about being self-critical of your own research. Here is an example of reflection after the second reflection session:

My supervisor thought that my research question was clear, but felt that my questionnaire needed to be redesigned and that I should include some open-ended questions. I have redesigned it and am now ready to trial it again, before carrying out the survey. My questionnaire has been made on Survey Monkey. I shall send out the survey in June just before the summer break and I hope to get 60% replies from the 150 women I want to survey. This should be an adequate sample. The appropriate statistical test for analysing data will be Pearson's product moment correlation.

The second reflection should also be about 100–150 words in length. Be aware that 'analysing' means explaining your results, not just describing them — a fault in many extended essays.

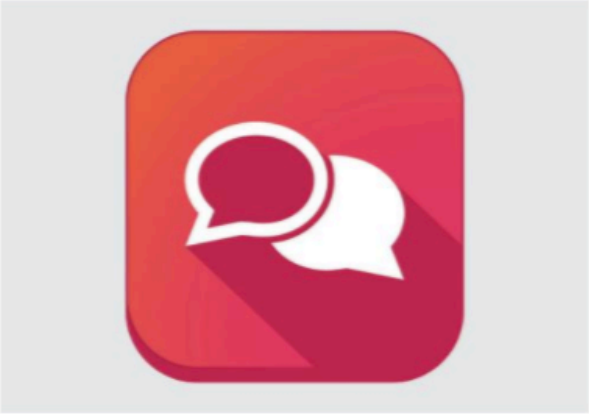
Completing the draft

Having collated your results and analysed them, now is the time to write a draft. You need to follow the basic structure of the essay and presentation that is recommended by the IB. You are expected to have a title page, list of contents, an introduction, an explanation of your inquiry (methodology), analysis, a conclusion and evaluation of methods. There should be a bibliography and appendices for information such as tables, formulas and questionnaires that don't need to be included in the main body of the essay.

In this draft essay, it is also important that sources are referenced and a standard form of referencing is used throughout. Please ensure that the draft is backed up. If possible, the draft should go through software such as Turnitin to ensure there is no unintended plagiarism.

Getting feedback

Your EE supervisor is expected to give you feedback on your draft essay. The feedback is usually about the content and presentation of the essay. Feedback may relate to how well the criteria have been met and what could be done to improve this.



It is important that your first (and only) draft of the essay is a full 4,000-word essay, so that your supervisor is in a better position to genuinely authenticate the work as your own, and to provide you with more meaningful feedback.

Note that your supervisor should not correct your essay for grammar or spelling mistakes. He/she is not expected to perform an exhaustive marking of the draft. However, it is important that you record their comments and ask for clarification if anything is not clear.

Completing the essay

You must fully prepare your essay so that it is ready for submission to the IBO. After receiving your draft essay from your supervisor, go back over the draft and reconsider the suggestions of changes that need to be made. Edit your draft, making alterations as necessary, and finish the essay in plenty of time before the final deadline and ensure that it is presented as a PDF ready to be uploaded by the DP coordinator or a nominated member of staff at your school.

The viva voce

The viva voce is the third and final reflection session, and will occur after the essay has been submitted. This is an opportunity to present the successes and failures of the essay. It is suggested that you focus on five things in this presentation:

- The clarity of the research question.
- The effectiveness of the investigation (how could this have been done even better?)
- Strengths and weaknesses of the analysis.
- Whether or not the research question has been answered successfully.
- Possible future areas of research that have been identified as a result of the research.

This last reflection session provides you with an opportunity to fully evaluate what has been done. The supervisor may well have questions about how you have carried out the research and some informal evaluation of your work. The final reflection should be based on the notes taken from this, and really stress how you have evaluated your research.

An example of a final reflection might be:

> My research question helped me to focus the inquiry into the topic. Gender issues have been one of the most fascinating parts of my geography course and this was the main reason for my research. Reports that I got from the Swiss Bankers Association and documents that I received from women's business groups really helped to develop potential research questions. However, it took some time to finally refine a research question. To get data on factors affecting women's status, I decided to distribute a questionnaire using Survey Monkey. The questionnaire I designed was ambiguous in some places in the wording even after doing a trial run and revising it. Some more open-ended questions would have gained more relevant information. The sample size could have been larger to get more accurate results or I could have distributed it before people went on holiday. However, I felt my analysis was sound but could have drawn out more points. While I was able to answer my research question, the process revealed more issues to be investigated. It would have been interesting to interview one of the executive members of the bank to get their opinion about promotion processes and opportunities within the bank. My supervisor was very helpful and supportive, helping me to clarify my ideas.

Next

The final reflection should be around 200–250 words. In total, the three reflections must not exceed 500 words on the RPPF. The IB rules stipulate that you will not be allowed to rewrite previous reflections once each reflection is submitted to your supervisor on the RPPF.

Your supervisor should...

- ...give you a copy of the assessment criteria and subject guide for your essay
- ...be knowledgeable about the subject area and provide suggestions about possible sources of information
- ...have three reflection sessions with you
- ...provide feedback on the full draft of the essay
- ...write a comment about how you have conducted the research process on the RPPF

John Cannings was a senior examiner for the EE in geography and for geography paper 2.

GROUP 2: LANGUAGES

Should you take the ab initio?

What are the advantages of taking an ab initio language course?

As an IB student you are asked to choose one subject from each of the six academic areas, although you can choose a second subject from groups 1–5. Some subjects you elect to do at a higher level (approximately 240 hours of teaching) and some at standard level (approximately 150 hours of teaching). Ab initio language is available only as a standard level subject, and you cannot elect to write the extended essay in a language you studied at ab initio level. The extended essay requires a high degree of competence in the language, which would be impossible after only 10–12 months of study in the ab initio course.

'I HAVE REALLY ENJOYED STARTING A NEW LANGUAGE FROM ZERO. IT HAS BEEN A NEW BEGINNING IN MY ACADEMIC CAREER.'

The aim of the ab initio is to develop a range of linguistic skills through the exploration of another culture via its language. You will learn about various aspects of contemporary society, family life and social structures in the wider commun[Next]hnic and regional diversity, as well as festivals and food, sports and games, travel and current affairs. You will consider how the culture and society have shaped and been shaped by the global community.

'IT IS NOT EASY BUT IT WAS GOOD TO CHANGE FROM THE LANGUAGE WHICH I HAD STUDIED FOR YEARS.'

Common questions

What's the difference between ab initio and SL/HL?

You will be familiar with different levels in subjects, such as mathematics with HL, SL and studies. A similar spread exists in group 2, but ab initio is not a superficial study of a language — it is a fast-paced course for beginners. You would be studying a new language from scratch, and in the space of just a few months learn to communicate in the target language in familiar and unfamiliar contexts.

Is ab initio like another language IGCSE?

The ab initio covers many of the same topics as an IGCSE, but crucially it is broader and more integral. It is designed in recognition of your age group and the IB's mission. It is fulfilling in the way that it addresses not only the basic day-to-day topics but also world issues connected with your chosen (target) language. You will be able to discover a wide range of cultural aspects on top of vocabulary and grammar.

'I HAVE NEVER BEEN GOOD AT FOREIGN LANGUAGES BUT I HAVE REALLY ENJOYED LEARNING A NEW LANGUAGE FROM SCRATCH AND I AM DOING WELL.'

This does not mean that only linguists should choose the ab initio. During the course you will develop the ability to read, write, listen to and speak the language. By the end of the course you will have the potential to be reasonably fluent, a skill asset that might make a difference to the content of your CV.

Is ab initio the right choice for me?

If you are a linguist, that is to say if you have a keen interest in languages and you pick them up quickly, this course is ideal for you. You will progress quickly and you will find that your prior learning of other languages is extremely valuable.

'THANKS TO THE AB INITIO COURSE I HAVE DONE HERE, I HAVE DECIDED TO CONTINUE MY LANGUAGE STUDIES AT UNIVERSITY.'

If you are a student who has had mixed experiences with languages, this course could also be right for you. You will be able to start afresh, among students who are also beginners, with a different attitude from earlier years of study in the middle school, because now you are a more mature individual, with the capacity to take on a more rigorous, as well as rewarding, experience.

What will I get out of it?

The ab initio course leads you to a functional competence. There is as much analysis of grammar as is necessary — fundamental vocabulary is key but you are not asked to memorise the whole dictionary. You will become a navigator — finding your way through the language and understanding its meaning by context and using a blend of your common sense and critical thinking.

'IN THE AB INITIO COURSE YOU LEARN A LOT OF USEFUL, PRACTICAL VOCABULARY.'

What is in the ab initio course?

Like all subjects within the IB Diploma, the ab initio course aims to achieve more than just competence in a language. It aims to develop international mindedness through the study of languages, cultures, and ideas and issues of global significance. The ab initio course aims to encourage, through the study of texts and through social interaction, an awareness and appreciation of a variety of perspectives of people from diverse cultures. Ab initio studies will also develop students' understanding of the relationship between the language of study, its cultures and the students' own.

'I HAVE STUDIED OTHER LANGUAGES ALREADY, AND I AM QUITE FLUENT, THEY HAVE A LOT OF SIMILARITIES WITH THE AB INITIO LANGUAGE WHICH I AM STUDYING.'

This will also develop your awareness of the importance of language in relation to other areas of knowledge. The ab initio course will provide you, through language learning and the process of inquiry, with opportunities for intellectual engagement and the development of critical and creative thinking skills. Furthermore it often inspires other opportunities for further study, work and leisure involving the use of the newly learnt language. Throughout the course it will foster curiosity, creativity and a lifelong enjoyment of language learning.

'THANKS TO THE AB INITIO COURSE I HAVE LEARNT A LOT ABOUT THE CULTURES IN OTHER COUNTRIES.'

'THE AB INITIO COURSE IS FAST PACED AND YOU ARE CONSTANTLY AWARE OF HOW MUCH YOU PROGRESS AND YOU FEEL THAT YOU ARE GOING SOMEWHERE.'

Ab initio students do not learn simple expressions in parrot fashion, but will be able to communicate in a realistic way in the language they have studied in a range of contexts and for a wide variety of purposes.

How is ab initio changing?

The current course framework for group 2 language acquisition is under review, however there are several similarities between the current course and the proposed one, which will become operational from September 2018. External assessment contributes 75% whereas internal assessment contributes 25% of the final grade. This will remain unchanged.

In the current model the external assessment consists of a reading comprehension task and two written tasks, that is to say a writing composition consisting of one short and one long written task, chosen from two and three options respectively, as well as a piece of personal research completed at home during the final year of study. In the future model the external assessment will consist of a reading comprehension task, a listening comprehension, and two written tasks of similar length but of different nature, chosen from three option

Next

The internal assessment (25% weighting) will remain similar, i.e. an individual oral lasting approximately 7 to 10 minutes with 15 minutes of preparation. It is in effect a conversation between the teacher and the student, based on a visual stimulus such as a photograph, and spanning more than one topic of the course.

'I WANTED TO STUDY A LANGUAGE SPOKEN IN A CULTURE WHICH WAS ENTIRELY NEW TO ME AND I HAVE ENJOYED THE JOURNEY OF DISCOVERY.'

Alessandra Symons has taught Italian at Sevenoaks School in the UK since 2003, and is an examiner and an IB workshop leader. **Rod Rands-Webb** has taught Spanish and French at Sevenoaks School since 2013.

GROUP 5: MATHEMATICS

Activities to aid your learning

Desmos classroom activities provide you with some new ways of learning mathematics that increase your flexibility and creativity as a problem solver. Could this help you answer difficult questions in mathematics exams?

Desmos started in 2011 as a free, easy-to-use online graphing calculator. If calculating and graphing is all you've used it for, however, then you've been missing out. Over the past couple of years, Desmos has developed classroom activities that have enabled ways of learning mathematics that are fundamentally different, and in many ways superior, to traditional approaches: **www.desmos.com**

One of the first classroom activities was 'Function carnival', which invites students to sketch the graphs of different events such as the height of someone fired from a cannon, bumper car rides and the motion of a Ferris wheel.

Struggling in exams?

Have you ever complained that IB mathematics exam questions are not like the ones in the textbook? Students often express such a concern, yet a mathematician who has never seen IB exam questions before could in most cases score a 7 on the exam in a fraction of the allotted time. Why is that? In order to understand students' difficulties in exams, we need to understand what it means to 'know' mathematics.

Students are used to learning procedures by seeing an example in a textbook (or by the teacher) and then copying that procedure on many similar exercises. Sound familiar? One aspect of the IB is that in all subjects, the teaching and learning philosophy is different from the rote memorisation of procedures found in some other school systems. Instead, teachers are asked to teach according to the IB 'approaches to teaching', including emphasis on **conceptual understanding** and **inquiry**. Students are encouraged to develop their 'approaches to learning', which include thinking, communication and research.

Theory of knowledge

1 What is the relationship between the specific examples used in Desmos activities and generalisations to mathematical theorems? Do we as teachers and students need one, the other, or both to know mathematics?
2 What knowledge is gained from doing different kinds of exercises in mathematics? What does it mean to really *know* mathematics?
3 In what ways do students learn mathematics differently if they graph functions or do calculations by hand compared to using a digital tool? For what knowledge may the different approaches be more useful?

Questions in IB mathematics exams and the requirements of the internal assessment fit with the approaches to teaching and learning in the sense that they most often are previously unseen **problems** rather than routine exercises. They ask students to:

- *reason* mathematically (convince oneself and others) through new and unfamiliar problems
- develop solutions based on deeper understanding of the relevant *concepts* (such as quadratic functions and triangles)
- apply and eval[illegible]thematical *models* to understand a process in the world around us
- *communicate* clearly: this is essential because without having clear mathematical language, you cannot think clearly about concepts nor convince others of your reasoning, or present solutions to problems or **modelling** tasks

So conceptual understanding, reasoning, modelling and communication are all vital to scoring highly in IB mathematics exams. Desmos makes it easier to develop these abilities.

Learning about functions

What is a function? The traditional lecturer or textbook **skill-and-drill method** would first shows you the definition and vertical line test, then ask you to apply the vertical line test (or some other procedure) on 20 different examples until you've really hammered that procedure down, though you might still be wondering why it works. With Desmos, you can use a card sort activity to sort different functions and non-functions (in several representations) into the correct categories (Figure 1). By doing so, you are developing conceptual understanding because, research shows, conceptual understanding is built when:

- you see multiple examples and non-examples of the concept (in this case functions and non-functions)
- you use multiple representations (in this case graphs, words, formulas) of the same concept

Later in the same activity, you are asked to reason and communicate about what is and isn't a function given two similar examples (Figure 2).

Desmos allows your teacher to share your responses with your classmates, so that together you can discuss the relative merits and limitations of different ways of approaching the same problem. In this way, you can collaborate with your classmates to further enhance your understanding by seeing multiple perspectives and solutions to the same tasks. The teacher can also make the responses visible but anonymous so that nobody feels embarrassed in front of others.

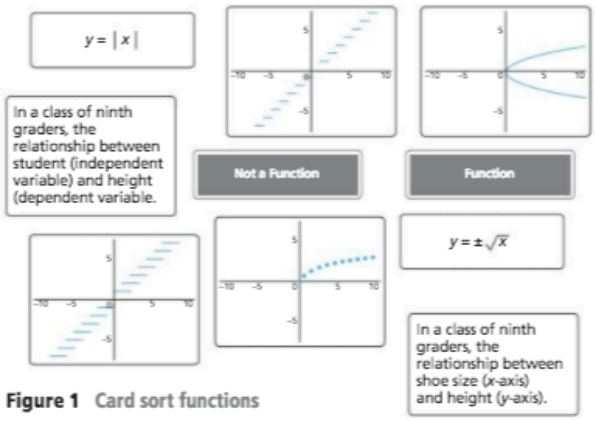


Figure 1 Card sort functions

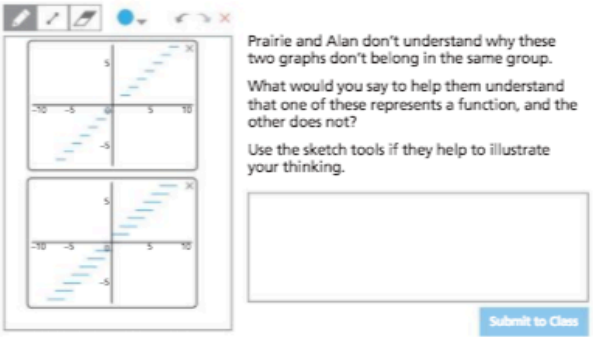


Figure 2 What's the difference?

Glossary

Conceptual understanding Being able to explain a concept to someone else, recognise it in unfamiliar situations, and communicate about it using multiple representations.

Inquiry Approach to teaching and learning in which the student learns through exploration of some concept, thereby forming his or her own conclusions.

Modelling Developing, applying and evaluating mathematical representations (models) of the tangible world.

Problems Any mathematical tasks for which students do not have a set of procedures at the ready.

Procedural knowledge Knowledge about which procedures to use in which cases.

Skill-and-drill method Traditional teaching and learning approach in which a teacher or textbook shows an example exercise with a solution, which is then copied by students on many similar exercises.

Reflection

Later still, you are asked to sketch your own example of a relation that may be difficult to identify as a function or non-function. Such a task involves both problem solving and some important reflection on your own understanding of the concept of function (Figure 3).

Reflecting on your own understanding is an example of something psychologists call **metacognition**: thinking about one's own thoughts. Metacognition is important for students, because only when students have accurate understanding of their own learning can they plan their studies appropriately. Often, the ways that students study — reading textbooks or notes, doing easy exercises — can give them a false sense of having mastered the content and skills. Desmos invites you to create your own examples, think through challenging and unfamiliar problems, and other tasks that highlight what you have and haven't yet mastered.

Later on, you might be learning about specific types of functions as well as function transformations, for example:

$$f(x) = a + (x - h)^2 + k$$

The skill-and-drill approach would be that someone tells you how functions are changed by the parameters a, h, and k, and then you would practise identifying those parameters from many different graphs. The Desmos way uses *inquiry*, so you would play with marble

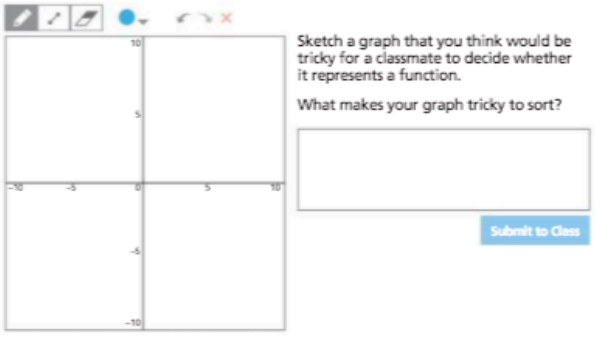


Figure 3 Sketch a tricky graph

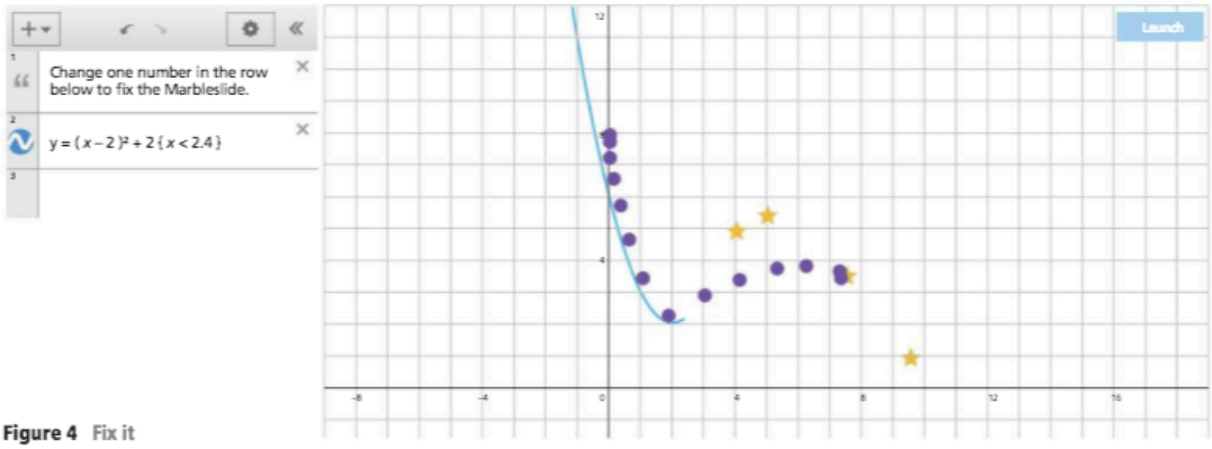


Figure 4 Fix it

slides (**https://teacher.desmos.com/marbleslides-parabolas**) and thereby discover and practice your understanding of the parameters in a more creative way, by figuring out parabola-shaped slides for marbles to slide down in order to fly through golden stars (Figure 4).

Using Desmos

While you can use the activities without signing in at all through the 'Student Preview' button, it is worth creating an account so that you have a saved record of all your work and can create a teacher account to easily make your own activities or edit the activities that are shared by others. As you start making your own activities, remember to enable Desmos Labs (under your name in the top-right corner).

It is possible to do Desmos activities on your own, but to get the most from them you should work in groups. One option is to recommend Desmos to your teacher, who can use and design their own activities to give to your class during lessons or as homework. Or you can set up study groups in which you do Desmos activities together.

The reason that groups work best for Desmos is that Desmos encourages discussion and reasoning rather than comparison with a mark scheme. For example, below you see a screenshot of the teacher dashboard with some of my own students' responses to a question about absolute value transformations:

12 Slanted asymptotes: algebraically

Come up with a function that you think will have a slanted asymptote of $y = -\frac{1}{2}x$

Test your predicted function on the following slide.

Responses Overlay Summary

EXPRESSION	STUDENTS
	Jacob Bernoulli, Marjorie Rice
$\frac{(4x^2+2x+1)}{-8x-4}$	René Descartes
$\frac{-1x^2+2}{2}$	Courtney Gibbons
$\frac{1(-1+2x^2)}{-2-4x}$	Artur Avila
$f(x)=\frac{-2}{2x+3}$	Gottfried Leibniz
$-\frac{1x^2+2x}{2x-1}$	Andrey Kolmogorov

They don't quite agree with each other, and rather than give them the correct answer I will have them discuss their answers and sort out their disagreements on their own.

Something else to keep in mind is the need to reflect on and summarise your learning after a Desmos activity, just like with every other learning activity. What were some essential understandings? What is still unclear? What are the next steps in our learning of this topic? You can collect your thoughts, and those of other members in your study group, at the end of a Desmos activity.

While Desmos offers opportunities for developing mathematical knowledge beyond **procedural knowledge**, it is still important to practise applying the understanding you build through Desmos to the kind of problems you may face in an exam. Try to get access to exercises as similar as possible to actual exam questions, and as you work them out, connect back to your understanding of the concepts relevant to those questions. Rather than doing many similar exercises on the same topic, try to use as many different exercises as possible, and pick ones that feel challenging to you. Rather than doing many quickly and superficially, do fewer but reflect on what you are doing, what understanding is required, what approach is suitable and why. What would have happened if the question had been slightly different? Is your communication of the solution clear, reasonable and understandable to others?

Questions and activities

Go to **www.student.desmos.com** and type in the codes below. If you make an account, you will have access to all the activities you've completed.

- Function carnival: 8EYXF
- Penny circle (modelling): 9NC5G
- Exponential functions: KDVR9

Tasks that develop conceptual understanding, by researcher Malcolm Swan: **www.tinyurl.com/conceptual-malcolm-swan**

Desmos learning videos for classroom activities: **http://learn.desmos.com/teacher**

Julia Tsygan teaches mathematics and psychology at the International School of the Stockholm Region, where she also leads development of digitalisation and other teacher professional development.

Next

GROUP 3: BUSINESS MANAGEMENT

Elkington's triple bottom line

Paul Hoang looks at applications of the triple bottom line

Twenty-first-century business operations have an important role in ensuring sustainability by creating a balance between the ecological, social and economic needs of people today and those of future generations. This might, for example, include the use of green technologies and recycling. There has been growing interest in the reporting of the triple bottom line (TBL) across for-profit, non-profit and government organisations to evaluate their performance.

Elkington's model

Sustainability is a concept that promotes intergenerational equity, i.e. business activity enables consumption of goods and services for the people of today without compromising consumption for the people of tomorrow. Sustainability is about meeting the needs of the current generation in such a way that it does not jeopardise the needs of future generations. The triple bottom line (TBL) is a framework for sustainable business activity, with three 'pillars' that support sustainability (Figure 1):

- ecological (or environmental) sustainability
- social sustainability
- economic (or financial) sustainability

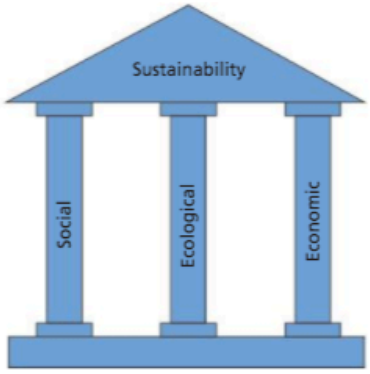


Figure 1 Elkington's pillars of sustainability

Overfishing is not ecologically sustainable

John Elkington, a world-leading writer on the topic of sustainability, created the TBL model in 1994. Elkington's pillars of sustainability are sometimes referred to as the **three Ps of sustainability**:

- people
- planet
- profit

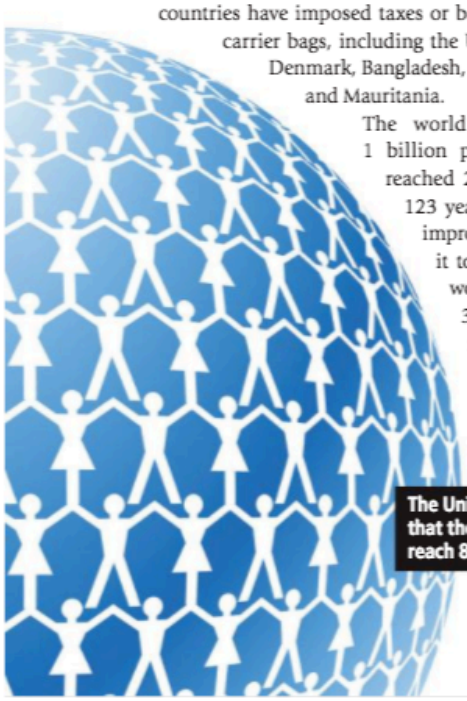
The TBL requires that an organisation's responsibility lies with its stakeholders rather than only its shareholders.

Ecological sustainability

Ecological sustainability refers to the capacity of the natural environment to meet the needs of the current generation without risking the ability of future generations to meet their needs. For example, overfishing or deforestation are not ecologically sustainable. A lack of ecological sustainability means that production can deplete the Earth's natural resources for future generations.

Ecological sustainability requires efficient and sensible use of the planet's scarce resources so that they do not become exhausted. For example, a report in *Business Insider* found that China's ban on plastic carrier bags saved the nation over 4.8 million tonnes of oil. Many countries have imposed taxes or bans on the use of plastic carrier bags, including the UK, Ireland, Italy, Spain, Denmark, Bangladesh, Hong Kong, South Africa and Mauritania.

The world's population reached 1 billion people around 1804. It reached 2 billion by 1927 (some 123 years later). However, with improved standards of living, it took just 33 years for the world's population to reach 3 billion in 1960. It then more than doubled to over 7 billion in 2011.



The United Nations estimates that the global population will reach 8 billion by 2030

Box 1 Ecologically sustainable business

Green technologies: environmentally friendly innovations that consider the long-term impact on the environment, e.g. renewable energy sources such as solar panels and wind turbines.

Recycling: turning waste products such as plastic and glass bottles into reusable materials.

Ecological footprint: the impact of resource consumption and waste production on the natural environment, e.g. cycling rather than driving to work, or using online technologies for business meetings instead of flying overseas.

Conservation: using the planet's scarce resources in a sustainable way by using renewable resources, such as trees and fish, at a rate that enables these resources to self-replenish.

Preservation: protecting the Earth's resources by reducing the human impact on the physical, natural environment and the cultural environment, e.g. rainforests and heritage sites.

Theory of knowledge

1 Is it possible to place a realistic value on the environmental and social costs of economic activity?
2 What ways of knowing apply when considering the concept of intergenerational equity?
3 How do we know what monetary value to put on the loss of forests or endangered habitats caused by business activity?
4 Do scientists or entrepreneurs know best about sustainable business activity?

The United Nations estimates the global population will reach 8 billion by 2030.

This exponential population growth puts huge pressure on the world's finite resources and makes ecological sustainability a key priority for many production managers and business executives. Hence, ecological sustainability requires businesses to consider more environmentally friendly practices (Box 1). There can be cost-saving benefits for the business too, such as reducing waste from packaging, which can help to reduce costs of production.

Social sustainability

Social sustainability examines the ability of businesses and people to develop in such a way that they can meet the social wellbeing needs of current and future generations. It enables society to optimise the quality of life for people and their descendants. By contrast, social hurdles prevent a community from advancing, e.g. poverty, unemployment and social exclusion (such as racism and gender inequalities).

Elkington argued that male business leaders need to accept women as equals if there is to be social sustainability and development.

> For every moment we remain silent, we conspire against our women.
>
> Nelson Mandela

Indeed, embracing social justice can bring about many business opportunities in terms of recruitment, retention and reputation. Gender discrimination (Box 2) represents an inefficient allocation of human resources. The United Nations Development Programme (UNDP)

argues that gender equality is fundamental to both economic and human development. From a humanitarian viewpoint, removing social inequalities gives communities a better chance of achieving sustainable development.

In addition to creating jobs and paying taxes, many countries expect businesses to fulfil their **corporate social responsibility (CSR)**. CSR refers to the voluntary actions that businesses take that are over and above compliance with minimum legal requirements in order to address both their own competitive interests and the interests of the wider society. Ignoring CSR can attract unwanted media publicity. Hence, an increasing number of businesses apply CSR in their practices.

Economic sustainability

Economic sustainability refers to development that meets the economic needs of the present generation, using existing available resources, without compromising the ability of future generations to meet their economic needs. It requires businesses to consider which resources (land, labour, capital and enterprise) are not used efficiently in order to correct the situation.

The overuse of resources is a major threat to economic wellbeing. Increased global demand and consumption makes it ever more difficult to sustain the output of goods and services over time. For example, the use of energy sources that use fossil fuels (e.g. coal, oil and natural gas) has huge repercussions on the natural environment, including climate change (Box 3). The rapid economic development in China and India has resulted in high levels of pollution and environmental damage. Globally, economic activity has led to the rapid depletion of the world's finite resources, especially non-renewable resources. With the continual rise in world population, the question for businesses is whether economic growth and its associated impact on the natural environment are sustainable.

Economic sustainability requires businesses to be more responsible in their use of resources, e.g. using materials that are environmentally friendly, easier to recycle or that are biodegradable. Paying attention to sustainability improves the chances of business success in the long run. However, in their endeavour to maximise profits and due to the potentially higher costs of operating in a sustainable way, businesses often do not make efficient use of available resources. Resistance to change or reluctance to embrace the ethos of sustainability creates further obstacles for economic sustainability.

Nevertheless, most analysts believe that economic sustainability is vital for any business striving to establish profitability over the long term. From this perspective, economic sustainability as a business strategy helps the firm to survive, thrive and contribute to the economic wellbeing of others via the creation of jobs and wealth.

Limitations of TBL

The main issue with TBL is not the definition but establishing a common measure of sustainability, particularly ecological and environmental sustainability. While profit (economic sustainability) is measured in dollars, it is far more difficult to measure social capital and the environmental health of a business. For example, it is difficult and highly subjective to put a monetary value on the loss of forests or endangered habitats. Hence, it is difficult for businesses to sum across all three of their bottom lines on their financial accounts. This makes it hard for businesses to determine the monetary value of the benefits of using the TBL.

Box 2 Gender inequalities

- According to the UNDP, discrimination against women and girls is the most persistent form of inequality.
- According to the Australian government, two thirds of the 800 million people in the world who lack basic literacy skills are female.
- Estimates from the UNDP show that in many South Asian countries like India and Pakistan, fewer than 35% of women are in paid work. The global average is 53%.

Box 3 Pollution allowance at Panasonic

In 2014 Panasonic introduced a wage premium to expatriate workers in China. The Japanese electronics company became the world's first company to introduce a higher pay scheme to compensate employees sent to China due to the country's hazardous air pollution. According to the US embassy in Beijing, air pollution in China's capital city is more than 16 times the World Health Organization's safety guideline.

While the TBL incorporates the social, environmental and economic (people, planet, profit) dimensions of sustainable development, it ignores the explicit focus on time in assessing the short-, medium- and long-term consequences of business activity.

Conclusion

Elkington argues that the TBL is an important business management tool to support sustainable business activity. The TBL has changed the way that businesses — be they non-profit, for-profit or public sector organisations — measure sustainability and the financial performance of business activity. However, businesses face challenges putting the TBL model into practice due to the subjective nature of measuring social and environmental sustainability.

Nevertheless, Elkington argues that only businesses that account for the TBL truly realise the full costs involved in doing business. This argument is logical — businesses measure what they believe to be of value to them in the long run. Only by accounting for, or measuring, their social and environmental impact, in addition to their economic impact, will they be socially and environmentally responsible in the long run.

References and resources

Economist Intelligence Unit, 'Doing good: Business and the sustainability challenge', **www.tinyurl.com/pyz2svs**

Elkington, J. (1997) *Cannibals with Forks: the Triple Bottom Line of 21st Century Business*, Capstone.

Savitz, A. W. and Weber, K. (2006) *The Triple Bottom Line: How Today's Best-Run Companies Are Achieving Economic, Social and Environmental Success — and How You Can Too*, Jossey-Bass.

Taylor, A. (2012), 'China Says Its Plastic Bag Ban Has Saved 4.8 Million Tonnes Of Oil', *Business Insider*, **www.tinyurl.com/pd6ncly**

Paul Hoang teaches at Sha Tin College, Hong Kong and is the author of several textbooks for the International Baccalaureate

Next

GROUP 4: BIOLOGY

Collecting data for your internal assessment

Pierre Dawson explores different strategies you might employ as you approach your biology internal assessment

In your biology internal assessment (IA) you will be tasked with carrying out a 10-hour research project that will count for 20% of your overall grade.

Three steps to the IA

Step 1: choose a topic

The IB biology course allows you flexibility in approach, and total autonomy when it comes to choosing the topic, scope and method of your internally assessed biology research project. You should decide on a topic that interests you, perhaps inspired by what you have learnt in class, observations of your natural surroundings or by any additional reading you have done around the subject.

For instance, one student, a member of the school swim team, wanted to know whether the chlorinated pool water was damaging her hair, and if so, would any hair care products be able to prevent or reverse this harm? With the topic chosen, next came the challenging task of developing a focused research question.

Step 2: develop a research question

Attempt 1
'What hair care products prevent hair damage in swimming pools?'

This draft question is not well focused on biological concepts or processes.

Attempt 2
'To what extent does exposure to hair care products reduce damage caused by chlorinated pool water?'

Quite similar to the first.

Attempt 3
To what extent does exposure to hair care products reduce the damage caused by chlorinated pool water, measured by testing tensile strength of individual human hairs?

Now incorporating specific variables and biological concepts.

With each attempt at writing the research question, the student gains focus. Ideally you should try to include the independent variable and range of values used, dependent variable, and scientific name of the biological subject(s) investigated. For the example above, would it improve the question to add the types of hair care products tested, or would it make it too long and reduce clarity? How important is it to mention that the hair tested is human? Should you write *Homo sapiens* instead?

Articulating your question well is a skill that can be learned through practice. The success of your IA depends on the quality of the question. The more focused, clear and feasible to answer in a productive 10 hours of researching, the better the outcome.

Step 3: gather evidence

To answer your research question, you must collect evidence (qualitative and quantitative data) that can be processed and interpreted. By the end of your investigation, you should be able to identify correlations (if found) and attempt to explain your findings using scientific theory. This is where a choice of method arises.

There are many ways to collect evidence for a scientific investigation. Your options include:

- a hands-on laboratory investigation
- using a spreadsheet for analysis and modelling
- extracting data from a database and analysing it graphically
- using an interactive and open-ended simulation
- an ecology study
- a mixture of any of these methods

Possible approaches

A hands-on laboratory investigation

This is the most popular option, perhaps an area of biological research where students (and teachers) feel comfortable and confident changing an independent variable and measuring a dependent one in a traditional laboratory environment.

While studying topic 2.5 (enzymes), students are often inspired to investigate factors affecting the rate of enzyme-catalysed reactions. For example, a popular idea is to alter the conditions surrounding the decomposition of hydrogen peroxide and measure the impact on reaction rate. Factors that can be changed include:

- presence of catalase enzyme
- pH
- temperature
- substrate concentration

One way to measure the rate of this reaction is to record the volume of oxygen released by the reaction over time. Students have used a range of apparatus to measure the rate of evolution of oxygen gas, such as displacement of water in a measuring cylinder, a gas syringe or an atmospheric ox[Next]robe. Each has their advantages and disadvantages, though they are increasingly more precise. Choosing the most appropriate apparatus involves weighing up accuracy and precision of measurements taken vs the time taken to collect the data and availability of the apparatus.

Theory of knowledge

1 What effect does you choice of model have on the interpretation of data?

2 Can virtual experiments in the natural sciences gather reliable evidence? How can software programmers ensure that they faithfully reproduce natural processes?

To what extent does exposure to hair care products reduce the damage caused by chlorinated pool water?

An excellent investigation I read recently, inspired by topics 2.5 and 8, investigated whether vitamin C has an inhibitory effect on catalase. The research question was focused and the lab report carefully guided the reader through the project, explaining what had been done and why, and what was discovered. Another investigation compared catalase activity in different vegetables.

Whatever the topic, the independent, dependent and control variables must be carefully thought out to ensure that the topic leads to the collection of valid results. Common pitfalls related to gathering data through laboratory investigations include underestimating the time and cost of sourcing materials, and having to develop a protocol that will reliably yield sufficient valid data to help answer the research question.

Teachers are experienced in the use of protocols that they continue to refine throughout their careers, which (hopefully) yield data that can be interpreted in a meaningful way. For many students, this will be the first time that they have had to develop their own methods. What apparatus should you use? What concentrations to make solutions? What to measure and how? What measurement uncertainties will be encountered?

The best way to find the answers to these questions is to carry out preliminary experiments with advice from your teacher. Getting the right method for gathering data that will help you to answer your research question is vital. Any major flaws in the exploration (planning) part of your investigation will make it difficult to write a high-quality analysis and evaluation.

Using a spreadsheet

Using a spreadsheet for analysis and modelling has huge potential as an alternative to a hands-on laboratory investigation. For this type of investigation, you will need to collect some primary or secondary data to process using a spreadsheet program such as Microsoft Excel or Google Sheets. The principles of the scientific method remain the same here as with all of the different possible methods of research: data are collected and analysed to answer a research question. Here, the focus is on analysing the data and using them to model potential trends. Models are important in scientific research because they allow us to simplify and understand complex phenomena.

Examples I've seen of this type of investigation include analysing atmospheric levels of carbon dioxide measured by the Mauna Loa Observatory. These data are available on the National Oceanic and Atmospheric Administration website. Students have compared atmospheric greenhouse gas concentrations recorded by different observatories around the world, creating predictive models. This could be linked to various political agreements and green initiatives over the years to try to measure their impact so far and estimate their effects in the future. Within this topic, you could consider trying to model carbon flows within the carbon cycle and look at the uncertainty involved.

Instead of looking at data on a planetwide scale such as greenhouse gases, one student used physiological data from Geneva University Hospitals that published the daily menstrual-cycle-regulating hormone levels of 20 women over 30 days. The student was interested in the control mechanisms of the menstrual cycle and compared the hormone levels in each of the different test subjects, looking for differences in timings of peaks and troughs as well as concentrations of each hormone.

Analysing data from a database

Extracting data from a database and analysing it graphically involves sourcing and then analysing secondary data to answer a question. Some students ask a question and then try to find a database that contains enough information to answer it, others search the internet for databases then look to see if they are inspired to ask a question regarding what they see.

When I teach topic 5.4 (cladistics, the classification of organisms based on evolutionary ancestry) I use the National Center for Biotechnology Information (NCBI) database to search for gene or genome sequence similarity between different species in order to draw a cladogram and see how closely related they are. There is an interesting protocol on page 137 of C. J. Clegg's *Biology for the IB Diploma* (2nd edn) that shows you how to do a BLAST search of the NCBI database to compare the gene sequences in different species that code for the enzyme cytochrome C oxidase. This enzyme is found in the inner membrane of mitochondria and is involved in the electron transport chain of aerobic respiration.

I use this activity to show my students the huge potential of database research in the field of bioinformatics, comparing DNA

or RNA sequences (genomics) as well as primary protein structures (proteomics). Once they are familiar with the basic techniques of sequence comparison, they think of questions that could be answered using these methods.

One student wanted to know whether the dates given for the evolutionary divergence of various mammal species were the same using DNA evidence and analysis of fossil records and physiological comparisons. They compared the gene sequences in different mammals that code for well-known proteins such as insulin, amylase and growth hormone, and then produced a mathematical model based on mutation rate to see whether the differences in gene sequence correlate with current estimations of when each mammal species diverged from their common ancestor.

Another student was interested in the endosymbiotic theory, and wanted to map the evolution of gene sequences that code for the components of ATP synthase in both prokaryotes and eukaryotes to see whether this would provide evidence to support the theory. Other fields that could provide secondary data for analysis include data on food consumption (nutrition and health), disease (epidemiology) and conservation (International Union for Conservation of Nature red and green lists).

The challenge with this type of investigation is that it is difficult to write the method in a traditional lab report for a reader who may not be familiar with this type of research. Clarity is key, with screen shots of key moments in the method, as well as ensuring that you give the URL to locate the database and that it is freely available for the teacher and examiner to access. My advice when writing methods is that other students should be able to read your protocol and reproduce your experiment without having to ask you for any clarification. If on reading your method they cannot search the database as you did then you have not articulated your protocol for collecting evidence clearly enough. You will lose marks in the communication and exploration aspects of the grading criteria.

Using a simulation

You can use a simulation provided it is interactive and open-ended. Many great simulations exist for teaching topics in biology — they are programs that allow you to carry out an experiment on a computer. Some simulations are extremely simple and have only been designed to demonstrate a process, however more complex simulations allow you to conduct a virtual experiment.

Advantages of collecting data using simulations are that you do not need to order and set up equipment, you can collect a lot of data in a short time and you can experiment in different locations and on different time scales. A huge disadvantage is that a computer model may not accurately portray what would occur in nature, so you need to be careful to acknowledge the weaknesses of the simulation in your evaluation.

If you are tempted to try this method, my advice is to carefully select your simulations. They must be freely available on the internet and provide enough data to allow meaningful conclusions to be drawn. One student investigated the effect of light intensity on the predation of peppered moths using a simulated ecology practical to generate data. To do this in real life you would need significantly more time and thus the investigation would be beyond the scope of an IB internal assessment.

Another student used an evolution simulation based on Darwin's finches. The program allowed them to alter environmental conditions in the Galapagos Islands and showed changes in populations of different species of bird over thousands of years. Again, this is an example of an investigation that is only possible using data collected from a simulation.

Ecology investigation

If you enjoyed studying ecology and conservation then an ecology investigation may be a good option to consolidate knowledge in this area. Some students carry out their investigation in the local environment surrounding their school, while others collect their data while on an ecology field trip. Either way, you must make observations of the ecosystems around you and start to ask questions about the relevant abiotic and biotic factors present. Are there any visible patterns? What relationships could there be in the system? What data could you measure to try to show correlation? What background research would you need to carry out to try to explain any patterns found?

A popular choice is to look at the phenomenon of zonation, for example measuring indicator species (e.g. lichen on land or invertebrates in rivers) against an environmental gradient of pollution, or looking at factors affecting the distribution of invertebrates in the intertidal zone of a rocky sea shore. Ecology investigations allow you to gather a lot of data for processing, however it can be challenging to identify all the species you encounter and to control the variables that may influence your results. Ecosystems are complex so it is hard to isolate and explain individual components on their own. Conclusions from ecological investigations must consider the many factors that influence the data collected, such as seasons, weather and human activities. Do not assume that the examiner has been to the ecosystem where you carried out your research. Be sure to set the context of your research by including maps, photographs, diagrams and a description of your site so that the reader has a strong understanding of what you did and why.

A hybrid investigation

If you are tempted by more than one of these options, it is possible to carry out a hybrid investigation that collects primary data using a lab-based protocol and then uses any of the other methods (spreadsheets, graphing, modelling, secondary data from databases and simulations) to help answer the research question.

One student wrote an excellent report comparing the rate of photosynthesis calculated from their own lab-based data to that collected from various online photosynthesis simulations. The overall aim was to evaluate the validity of the different simulations compared with data collected manually. This approach enables you to draw on the strengths of different sources of data that will help you to better answer your research question. The challenge is to not get lost in too many different domains and to stay focused on answering your research question.

Conclusion

There are many ways to conduct research in biology. When deciding which path to take, you must take into account your personal interests and your willingness to take a risk, and most importantly choose the methodology that will give you data to answer your research question.

Pierre Dawson teaches IB biology at Tanglin Trust School, Singapore.

Next

TOK THEORY OF KNOWLEDGE

Serendipity and scientific discoveries

Pablo Picasso used to say: 'Inspiration exists, but it has to find us working.' What did he mean? Do you think we can find similar situations in science? Have you ever thought about how scientists come up with brilliant ideas to solve problems? Germán Tenorio explores the role of serendipity in science

The nature of science (NOS) section in the IB guide of the science courses (biology, chemistry and physics) helps us to realise and understand that science (and scientific work) is not just carried out by a single scientist following several steps of the scientific method. Actually, science depends on interactions with the shared knowledge within the scientific community, repeating the different parts of the scientific method by different people at different times in order to obtain new information. In addition, the scientific process is not something static carried out in a lab, but it is a dynamic and, most of time, unpredictable process. Finally, creativity is an important factor in science, because in discovering new things or explanations to a problem, new approaches to the same problem must be given.

Science is mostly based on careful observations behind a tireless process of research, such as the use of Rosalind Franklin's X-ray diffraction, which provided definitive evidence that DNA is a double helix, or Michael Faraday's observation of electromagnetic induction. However, some of the most important discoveries, such as the discovery of penicillin or radioactivity, are clear examples of how lucky events have a deep impact on scientific discoveries.

You may think that someone could make a scientific discovery by a stroke of luck, but in fact, this is far from being true. Although anyone could a find a coin on the ground by chance, not everybody can realise that an incorrect result from an experiment can be used as an application to solve another problem. Scientific discoveries where chance is involved are known as **serendipitous events**.

Serendipity and TOK

Although the word 'serendipity' is often used as a synonym for 'chance', serendipity is not just chance. While we recognise chance as something opposite to rationality or critical thinking, serendipity presupposes a fluency with relevant knowledge that has already been established in a community. In this sense, serendipity is defined as the rational exploitation of chance, especially in the discovery of something useful or beneficial. One important aspect that has to be taken into account in order for an event to qualify as serendipitous is that the thing discovered is something that the discoverer had not been looking for.

So serendipity is associated with discoveries that are not just down to chance, but arise from it, together with an intellectual effort that derives the discovery from the chance event. The TOK course identifies eight specific ways of knowing. Intuition is one of them, which is often regarded as knowing without the use of rational processes. To what

extent might some of these scientific discoveries be the result of intuition rather than luck?

Discovery of penicillin

There are many examples of scientific discoveries associated with serendipity, especially those where cures were discovered for infectious diseases. One of the most well known serendipitous discoveries was the discovery of penicillin, the first antibiotic, by Alexander Fleming, professor of bacteriology at St Mary's Hospital, London, in 1928. After returning from his summer holiday, he began to sort through Petri dishes containing colonies of the *Staphylococcus aureus* bacteria that he had left on the bench. He noticed that one dish was dotted with colonies except for an area where a contaminating *Penicillium* mould had grown. The zone around the mould was clear, as if the mould had secreted something that inhibited bacterial growth.

Fleming found that the mould was effective not only against *Staphylococcus* but also a wide range of pathogenic bacteria, such as those causing pneumonia, meningitis, gonorrhoea, scarlet fever and diphtheria. Studies estimate that up to 200 million lives have been saved by Fleming's discovery, approximately twice the number of casualties in the Second World War.

Fleming discovered penicillin thanks to a stroke of luck, but could anyone have taken advantage of this chance observation? Probably not, because in serendipity, apart from being smart, a solid academic training in a discipline is essential. As Louis Pasteur said: 'Chance favours the prepared mind.' In TOK we talk about the shared knowledge of a community. In this case Fleming's previous expertise in science and his fluency with the concepts and methodologies meant that he immediately recognised the importance of this new observation. In fact, during his Nobel lecture in 1945, Fleming said:

> 'It arose simply from a fortunate occurrence which happened when I was working on a purely academic bacteriological problem which had nothing to do with antagonism, or moulds, or antiseptics, or antibiotics... . Penicillin started as a chance observation. My only merit is that I did not neglect the observation and that I pursued the subject as a bacteriologist.'

Theory of knowledge

1 Do you think that the role of serendipity makes the scientific method more or less reliable?
2 What role does an individual's understanding of the shared knowledge of a community play in serendipity?
3 Richet's discoveries depended on experiments on live animals, something many think should not be part of the scientific method. If an experiment violates the ethical treatment of test subjects, does that make the knowledge gained more or less valuable?

Serendipity is associated with discoveries that are not just down to chance, but arise from it, together with an intellectual effort that derives the discovery from the chance event

Next

Zoom

References and resources

The discovery and development of penicillin:
www.tinyurl.com/ln2hyue

Accidental discoveries: **www.tinyurl.com/8yo32yb**

Becquerel's discovery of radioactivity: **www.tinyurl.com/y72f6j68**

Viagra and other drugs discovered by accident:
www.tinyurl.com/ya45dozl

www.understandingscience.org

Meperidine for morphine

Another serendipitous discovery took place in the 1930s when the Austrian physiologist Otto Schaumann was studying an antispasmodic compound in rats while he was working at IG Farben, a German chemical company. He noticed that the tails of treated rats assumed an S-shaped curvature that had been reported previously for rats given morphine or other opioid analgesic drugs. Although the compound was not structurally similar to morphine, it proved to be a narcotic analgesic. Later, it was shown that this compound, now known as meperidine, has some structural features in common with morphine and they have the same active area. Meperidine was found to be less potent than morphine, causing fewer side effects and acting faster. Nowadays this drug is widely prescribed to treat moderate-to-severe pain under such trade names as Demerol in the USA.

The sudden appearance of S-shaped tails in treated rats is something that anyone could observe, but not everybody would have the shared knowledge or insight to associate it with the pharmacology of morphine. In TOK we differentiate between shared and personal knowledge. To what extent does personal knowledge not exist in scientific research? Under what circumstances should personal knowledge gained by scientific research not be shared?

Allergens and anaphylaxis

Fifteen years before Fleming's happy accident, French physiologist C. R. Richet starred in a lesser-known serendipitous event. He was studying how toxins affect the body by injecting trace amounts of poison from the tentacles of sea anemones into dogs. The allergic symptoms — including vomiting, shock and loss of consciousness — took some time to appear. Some of the dogs died from allergic shock, but others survived their reactions and recovered completely.

After some weeks, as the recovered dogs seemed completely normal, Richet made use of them together with new dogs for more trials. After they were given another dose of anemone poison, he noticed that symptoms took some time to turn up in the new dogs, as usual, but interestingly the recovered dogs suffered serious symptoms just minutes after the poison was administered.

Richet realised that he could not ignore the unexpected results of his experiment, so he kept researching, treating more recovered dogs with different doses of the poison. He proved that when an individual is exposed to an allergen a second time, the individual is even more sensitive to its effects than the first time, as the ability of the immune system to respond has been affected. His conclusions established the basis of allergic reactions and in 1913 Richet received the Nobel prize in recognition of his work on anaphylaxis.

Today we know that anaphylaxis is an exaggerated immune reaction involving immunoglobulin E antibodies as well as mast cells and basophils, which can affect several organs and may cause death. There is no specific data available about how many deaths have been avoided due to this discovery, but millions of allergic people have been positively impacted and even saved by the discovery of anaphylaxis.

Many serendipitous events are related to the discovery of new drugs. Further examples can be found in scientific literature, such as discovery that Viagra was an effective treatment of impotence in men (the drug was being investigated to fight angina and hypertension), or the discovery of levamisole, a successful treatment to kill parasitic worms in livestock that scientists realised by chance was synthesised naturally by the chickens.

Discovery of radioactivity

One of the most well known and important accidental discoveries in medical science took place in physics, when another French scientist, Henri Becquerel, discovered spontaneous radioactivity in 1896. Becquerel was studying uranium and phosphorescence, and subsequently discovered X-rays. These later turned out to be useful for medical imaging, since X-rays can penetrate human body flesh.

At the time, Becquerel thought that phosphorescent uranium salts he had been studying might absorb sunlight and reemit it as X-rays. To test this, Becquerel placed crystals of uranium salt on top of photographic plates that had been wrapped in black paper so that sunlight could not reach them. When he developed the plates, he saw that the plates

were clear except for an outline of the rock crystals. Becquerel took this as evidence that his idea was confirmed: he reasoned that the rays creating the image originated in the Sun, but had been transformed into X-rays, not realizing that the uranium crystals themselves were the source of the X-rays.

Becquerel accidently discovered the truth when he decided to continue his experiments. He wanted to run more repeated experiments but the weather in Paris was cloudy, so he stored his uranium crystals and photographic plates in a drawer for several days while waiting for sunny days. When the sunshine finally returned, Becquerel checked the photographic plates to make sure they were not damaged. When he opened the drawer and developed the plate (not expecting to see any image on the plate, because there'd been no sunlight), he was astonished to see an amazingly clear outline of the rock crystal on it even though the rock had not been exposed to sunlight at all.

Becquerel discovered radioactivity in 1896 thanks to the cloudy weather in Paris that week and his decision to store photographic plates and uranium rock crystals in same drawer. But serendipity came into play when he realised he had noticed something really important. A couple of years later Marie and Pierre Curie in Paris started to study the uranium rays, and Marie used the term 'radioactivity' to describe the phenomenon. Becquerel and the Curies shared the Nobel prize in 1903 for their work on radioactivity.

Serendipitous endeavours

All the discoveries above can be used to address the question: 'What is science and what is the scientific endeavour?' As the IB science guide says, 'Scientists also have to be ready for unplanned, surprising, accidental discoveries. The history of science shows this is a very common occurrence.'

So both fortuitous discoveries and difficult findings through careful observation are two sides of the same scientific coin. However, it would be a mistake to suggest that the role of chance and serendipity render scientific knowledge or the scientific process less reliable. Without the extensive shared knowledge of the community, the serendipitous events discussed here might have pass by unnoticed. How many other events of equal importance might we be missing even now?

Key points

- Not only is the progress of science based on meticulous and careful observations through the scientific method, but it also depends on lucky observations known as *serendipitous events*.
- Serendipitous events are not just strokes of luck. Serendipity relies on scientists' knowledge.
- Scientists gain personal knowledge by serendipity, which eventually becomes shared knowledge within the scientific community.

Germán Tenorio has a PhD in molecular biology and is an IB examiner and workshop leader. He is head of science and IB coordinator at the International School of Seville, San Francisco de Paula.

Leaders in
IB Teacher Training
ibicus.org.uk

Face-to-face workshops
Employing the world's top facilitators
Wide range of subjects at all levels
IB approved since 2007
Convenient centres around the world
Top quality training guaranteed

IB PROFESSIONAL DEVELOPMENT
DEVELOPING LEADERS IN INTERNATIONAL EDUCATION

ibicus

TOK THEORY OF KNOWLEDGE

Decisions decisions... are not really TOK

How can you turn an analysis of decisions into TOK?

We make a lot of decisions in the course of a day. What to wear, what to eat, what subjects to take, whom to vote for. Some of us (especially teachers) make so many decisions that in fact we suffer from 'decision fatigue'. The decisions we make are impacted by a wide variety of influences, and investigating these influences are an interesting topic of discussion in TOK classes. How does your cultural background, gender, education levels, religion and personal interests influence what decisions you make?

Our interest in decision making places the individual at the centre of the conversation, and exploring these influences helps us understand our place as knowers in the world. This is what TOK is about — how we as knowers interact in the world. However, these questions about individual decisions are really only the starting point for conversations in TOK.

Staying focused on individual decisions and the process of decision making is too focused only on the *individual* and how the individual's thought processes work. What makes *me* decide one thing over another is about my own particular circumstance and individual history, and any way of knowing's role in that process is ultimately really only an investigation into the psychological states and processes involved in my own specific decisions. In other words, how I make a decision is really a first order exploration within the area of knowledge (AOK) of psychology, and first order explorations are the worst thing you can do in TOK.

TOK decisions

Instead of asking how individuals make decisions, you can tie the discussion to an AOK, asking for instance: 'How does a scientist make decisions?' or 'What decisions would a historian make with this new evidence?'

Instead of thinking about the first order decision, you're now thinking about the second order principles upon which the individual will make those decisions. The scientist, for instance, will have to think about evidence and empirical observation. The historian will have to think about how the evidence presented makes sense of the motives and intentions of people from the past. Think of your decision maker in terms of that person being a representative of a shared community of knowers. That way you're now thinking of the individual as having *personal knowledge* and engaging with the *shared knowledge* of the community.

Scientists thinking about which theories to apply to the results of an experiment will have to take into consideration the reliability and objectivity of the theories that the community of scientists has already established — they can't just make up a new theory and think that the job is done. If they do, then they will be aware that their new theory won't have any validity until the wider community examines it and accepts it.

Ethics is always a popular subject of TOK presentations. Ethical decision making is also a popular topic, but all too often students ask about the ethical decision an individual makes rather than how that individual develops ethical principles, upon which the decisions are based. Ethicists have worked to develop guiding principles ('try to maximise happiness' or 'try to act virtuously'), and when trying to make ethical decisions an individual will be *applying* those principles. But if your TOK analysis is simply about the application of a principle ('which action would result in the most pleasure'), then you're merely doing first order ethics. Ask instead about whether it makes sense to measure happiness, or how ethicists make decisions about what counts as virtue. This will keep you closer to genuine second order ethics.

John Sprague is the lead editor of IB Review, teaches IB philosophy and is TOK coordinator at the Tanglin Trust School, Singapore. He is an examiner and an IB workshop leader. His *TOK: Skills for Success* is published by Hodder Education.

Get more from this issue of IB Review, with **free** online resources.
See page 1 and **www.hoddereducation.co.uk/ibreviewextras**

Tell us what you think #hoddermags

ISBN 978-1-4718-9165-6

Please note single issues are not available for separate purchase