



THE HYPOTHESIS BOX - THINKING ABOUT SCIENCE

Taken from Peter Worley's book '40 Lessons to Get Children Thinking', Bloomsbury September 2015

Equipment needed and preparation:

- ✓ An enclosed non-transparent box,
- ✓ A ball (optional - see below)

Starting age: 10 years

Key concept / vocabulary: Hypothesis, test, show, demonstrate, true, false, knowledge

Subject links: Science, RE and Philosophy

Key controversies: How is philosophy related to science? Can religious belief be treated in a similar way to scientific belief or are the two realms of belief disanalagous?

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There are two possible outcomes: if the result confirms the hypothesis, then you've made a measurement. If the result is contrary to the hypothesis, then you've made a discovery.

”

Enrico Fermi, Italian physicist

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Science is such that, when we get it wrong, reality answers back and tells us.

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Rebecca Goldstein Newberger

Critical thinking tool: *Falsification* - this is when someone tries not to *prove* a theory or hypothesis but to *disprove* it. For instance, if the hypothesis is 'all birds fly' then the best course of action when testing the hypothesis is not to look for examples that *confirm* that hypothesis but to seek out examples that would *disconfirm* it. If someone were to look only for examples of birds that fly, thereby confirming the hypothesis, then they would be falling foul of the fallacy of *seeking only to confirm*, sometimes known as *confirmation bias*. No amount of examples of birds that fly would truly prove the hypothesis; only one example, however, of a bird that does *not* fly would utterly refute it. This is known as *falsification* and is associated with the Austrian-British philosopher Karl Popper (1902-1994).

Key facilitation tool: *Counter-examples* - when children make claims, especially general claims then a good thing to have the class do is search for a counter-example to the claim. For instance, if someone says, 'Everything is possible,' then, if the class has not already begun to do so, ask, 'Can anyone think of an example of something that is *not* possible?'

SESSION PLAN:

The main aim of this session is to explore the conditions necessary for showing a hypothesis to be true. No tests are performed and no experiments are constructed other than in the minds of the students. It is a reasoning exercise about what outcomes would be expected when X or Y is done and about what outcomes would show the hypothesis to be true. This kind of enquiry would be an excellent way to get a class to prepare for constructing tests and experiments in science and to consider what variables matter in relation to the hypothesis. This exercise also shows the links between science and philosophy - philosophy being reason-based and science being distinguished by being experimental and empirical as well as reason-based. You can see the close link in the example below because in thinking about the necessary conditions one needs to have a clear understanding of the concept 'object'. This is where the *conceptual analysis* aspect of philosophy has a clear and important role in scientific reasoning.

Part one: The Object Hypothesis

Do: Before the session, and while the children are not there to see, put an item in a box such as a ball. Ask the class if anyone knows what a *hypothesis* is. Write up the word 'hypothesis' and do a concept map around it. Once this is done provide the class with a definition. Here is the dictionary definition:

* *Hypothesis*: a supposition or proposed explanation made on the basis of limited evidence as a starting point for further investigation.

Etymology: 'hypothesis' comes from the ancient Greek for 'foundation' and later went on to mean 'to suppose'.

For a younger class here's a simpler definition:

* A hypothesis is when you suppose something to be true before you know whether it is or not so that you can test it to see if it's true.

Write the following hypothesis up on the board:

Hypothesis: *There is an object in the box.*

Task Question: How can we find out whether the hypothesis is true or false?

Someone is likely to say, 'Open it.' If they do, then this is how to respond (The structure of your questioning should follow - more or less - this example throughout this session):

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Fac: If you open the box then what (outcomes) would you expect? (*Eliciting expectations*)

Pupil: You might see an object or you might not.

Fac: If you open it and you see an object then have you shown the hypothesis to be true or false? (*Iffing and anchoring*)

Pupil: True.

Fac: Can you say why? (*Opening up - justification*)

Pupil: Because if there's something there then... [the student continues]

Fac: If you open it and you don't see an object in it, then have you shown the hypothesis to be true or false?

Pupil: That depends.

Fac: What would it depend on?

Pupil: What an object is. Because if a germ or bacteria is an object then it would be true but if we mean something like...

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The questioning strategies at the heart of this session are *iffing*, *anchoring* and *opening up* and - a new strategy - *eliciting expectations*. This is where you ask the pupil to say what outcomes they would need in order to show that what they are saying is true or, to put it as you will say it in this session: *to show the hypothesis to be true*. It is asking them to say what conditions are needed. In normal English, something like: 'So what do you need to be able to show that?'

The Un-openable Box

You could make this task harder by making the following stipulation: 'If you could not open the box (for whatever reason) then how would you be able to find out if the hypothesis is true?'

1. shake the box.
2. weigh the box.
3. X-ray... and so on...

After each of these or other suggestions follow a similar structure to the 'object hypothesis' example above:

1. If you shake the box what would you expect?
2. If something rattles inside then would you have shown the hypothesis to be true or false?
3. If something does not rattle inside then would you have shown the hypothesis to be true or false? And so on...

EXTENSION ACTIVITIES:

More hypotheses suggestions

- ✓ There is an apple in the box.
- ✓ All birds fly.
- ✓ Teddy bears come alive when no one is watching.
- ✓ CO₂ is the same as air.
- ✓ Water and ice weigh the same.
- ✓ Unicorns exist.

- ✓ The theory of abiogenesis is true (research ‘abiogenesis’ or the theory of ‘spontaneous generation’, associated with Aristotle, and also research Francesco Redi’s famous experiments (1668) to test this hypothesis. Interestingly, the jury’s still out on abiogenesis when it comes to the origins of life itself!)

Remember: do not perform the test or touch the box; explore, using the above questioning structure how they would test the hypothesis. As a science follow-up, you could try to perform the test that was thought-up in the session.

Open the box?

You may decide, at the end of the session, to open the box and reveal what is inside. However, there is another enquiry opportunity here about the nature and relationship of philosophy to science: you could ask the following two-part question:

1. If this is a philosophy session then do we need to - and should we - open the box?
2. If this were a science session do we need to - and should we - open the box?

Nested Questions:

- ✓ What are the similarities, if any, between philosophy and science?
- ✓ What are the differences, if any, between philosophy and science?

The students’ responses to this can reveal two things: their understanding of the subjects of philosophy and science, but also their intellectual/philosophical maturity. There may be those in the class, sensitive to the intellectual value of not revealing what is inside the box. Those that respond this way demonstrate, in my view, a sophisticated intellectual maturity.

The God Hypothesis

With older groups ‘The Hypothesis Box’ session affords a great opportunity to explore another of the big questions in philosophy: the question of God’s existence. Do ‘The God Hypothesis’ after running the hypothesis session above so that the two contrast.

Do: Write up the following hypothesis:

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Hypothesis: God exists.

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Task Question: How, if at all, can we find out if the hypotheses is true?

Nested Questions

- ✓ Is ‘the God hypothesis’ analogous to ‘the object/apple hypothesis’? (Are they the same kind of thing?)
- ✓ What counts as evidence with the ball example and what counts as evidence with the God example?
- ✓ Is evidence necessary for faith?
- ✓ Even if you think there is no evidence for God are there any good reasons for believing in God?
- ✓ What is it to know God?
- ✓ What is it to know that God exists?

Related Resources

The Philosophy Shop: Epistemology: Knowledge (section),
Once Upon an If: Flat Earth, The Island