What would aliens think of science on earth? Philosophical dialogues in the museum to help children reflect about science

Jelle De Schrijver

Abstract

Thinking about what makes science science can help people develop both an understanding of and a critical attitude towards knowledge. In this case study we explore how children participating in informal science communication activities can think about science by engaging in philosophical dialogues. The dialogue facilitator's inquisitive stance helps children develop arguments about knowledge, scientists, and science. The use of philosophical questions and a cover story involving alien scientists enthuses most children, but some find it frustrating. However, frustration acts as a motivator enhancing further reflection. Introducing this approach at science museums or science festivals challenges science communicators to question rather than to answer.

Keywords

Public perception of science and technology; Representations of science and technology; Science communication: theory and models

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Context

Can invisible things be studied? Can truth change? Do scientists know best what is good for the world?… Children ask hundreds such big questions. Often, these questions are answered by parents, teachers, or science communicators eager to replace uncertainty with 'truth'. However, the children's questions can also function as prompts to enhance reflection about science. That is the focus of this case study: how can children's big questions act as levers to help them think about what makes science science?

Obviously, science covers a large collection of ideas such as the theory of evolution or Newton's laws. Science also denotes a method of building reliable knowledge. This method has its own (epistemological) assumptions about the role of uncertainty in science, the relation of science and society, or the difference between science and religion [Schwartz & Crawford, 2006]. To enhance public understanding about science, it is relevant for people to grasp this 'nature of

science' [Lederman, 2007]. After all, discussing ideas about science helps to dismantle the idea that science is a collection of facts rather than a method to build reliable knowledge [Colburn, 2004]. Reflection about 'nature of science' enhances both an understanding of and a critical attitude towards science and knowledge, by providing a framework and vocabulary to think about science, truth, and information [Yacoubian, 2020]. This is as relevant for children as it is for adults seeing as the basic ideas about science are (often implicitly) transmitted from a young age [Akerson, Buck, Donnelly, Nargund-Joshi & Weiland, 2011].

Tackling the more abstract aspects of scientific knowledge in the context of science communication is challenging. It may be easier to communicate about scientific ideas or breakthroughs than about science *itself*, because these scientific ideas relate to content, whereas epistemic aspects of science are harder to grasp. Nevertheless, if we were to focus only on ideas *of* science, we are misrepresenting it by reducing science to its key findings and breakthroughs [Yacoubian, 2020].

To overcome this challenge, we can look for help within the territory of philosophy. Philosophy is the domain that focuses on ultimate questions or, as the philosopher of science Bertrand Russell [2001] stated it: "*Philosophy is to be studied, not for the sake of any definite answers to its questions since no definite answers can, as a rule, be known to be true, but rather for the sake of the questions themselves*". The philosophical approach can help us think about the big questions that underlie all of science. The use of philosophical dialogues in an educational context is inspired by the philosopher John Dewey who argued for a form of education in which the emphasis is placed on the learners and the latter can take responsibility for their own learning process [Dewey, 1997]. Following this work, the American philosopher Matthew Lipman in the 1960s developed a methodology called 'philosophy for children' (p4c) [Lipman, 1988]. In this approach, philosophy is not only considered to be an academic discipline, but also a form of dialogical thinking [Lipman, 2003]. The purpose of this approach is to help children reflect critically and creatively about big (philosophical) questions by participating in philosophical dialogues. In a philosophical dialogue participants aim to answer fundamental questions by exploring ideas and providing arguments under supervision of a dialogue facilitator [Lipman, 2003]. The philosophical questions are open and invite participants to explore different perspectives to answer the problem at hand (e.g., Is an apple alive? Can a rabbit be a scientist? Would an alien have science?) [Dunlop & De Schrijver, 2018]. Just as in Socratic dialogues (originally described by Plato), participants delve into fundamental philosophical issues. In p4c these dialogues are not used to buttress a Platonic philosophy about truth, goodness or beauty. In p4c, philosophical dialogues help participants to explore different points of view and examine the argumentation for these ideas. This entails that the facilitator does not steer towards a final true answer, yet allows participants to explore as many perspectives as possible [De Schrijver, Blancke, Cornelissen, Sermeus & Dunlop, 2022]. The facilitator employs what is known as the Socratic stance. This means that the facilitator does not intervene in shaping the content of the discussion, but only stimulates the dialogue [Lipman, 1991; Schjelderup, 2009].

Objective

In this paper a case study is described: workshops were developed to invite 8- to 12-year-olds to think about science by participating in philosophical dialogues. The workshops were developed for the 'I love science Festival' in Brussels and the

Ghent University Science Museum (Belgium). We will zoom in on (1) the design, the evaluation, and the redesign of the workshops, (2) the children's responses to the intervention, and (3) explore the meaning of this approach for science communication.

Methods

The workshops for this study were developed according to a cyclical design-based research study [Barab & Squire, 2004]: different versions of the philosophical dialogue workshops were developed, evaluated, and redeveloped. In 2018, a first version of the workshop was developed and tested at the Brussels science festival. 46 children participated. Based on these experiences the first version was adapted which resulted in a workshop that was implemented during next year's 4-day science festival (2019) and at the Ghent University Science Museum (2021). 260 and 170 children participated in these 60-minute workshops. Parents had to register their children for these workshops. Often, parents were present when the children participated in the workshop. Throughout the workshops we could qualitatively document how they were received drawing on fieldnotes produced by the facilitator and brief semi-structured interviews conducted with children and parents. To make a record of the dialogues, we gathered notes from colleagues who were observing the workshops. Before the workshop started parents and participants were informed that the observers in the room would make fieldnotes to document the intervention. The parents gave oral consent for anonymously using the dialogue fragments for research purposes. In this paper, dialogue fragments are selected that illustrate the kinds of dialogues that emerge during these interventions. Both museum educators present at the dialogues and facilitators consider the dialogues to be illustrative for the dialogues that were facilitated.

Due to the set-up of the workshops at the science festival and in the museum, children participated in mixed groups with both younger and older children (8- to 12-year olds). The exact age of the participating children in each workshop was not recorded for this case study. This limitation makes it hard to differentiate between the responses of younger and older children. Although some of the participating children will have been more schooled in basic science than others, many of the participating children did show a great enthusiasm and interest for science and were (un)surprisingly knowledgeable about science. This may be explained by the fact that either the parents or the children explicitly chose to participate in workshops about science.

The dialogues were facilitated in Dutch. For this paper, the selected dialogue fragments were translated by a person who is fluent in Dutch and English. The quality of the translation was evaluated by three persons, including the person facilitating the dialogues, the author of the study and a colleague participating in the observations.

Findings

Version 1: philosophical questions

In a first version of the workshop the science communicator facilitates a dialogue focusing on philosophical questions about science. Children sit in a circle and

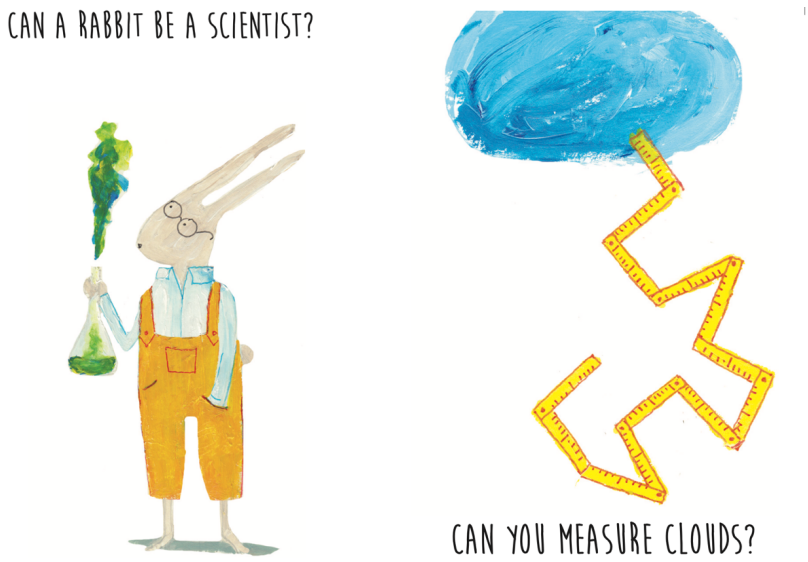

Figure 1. Examples of philosophical questions used in the first version of the intervention. (© ExploRatio — FiloZoo)

discuss the questions. Philosophical questions are introduced as questions that even Google doesn't know the answer to. A broad variety of questions are raised, ranging from 'Can a rabbit be a scientist?' or 'Can you measure clouds?' to 'Is a scientist responsible for the misuse of its discoveries?' These questions were either invented by the facilitators or the children. Many of the philosophical questions were illustrated with drawings (see Figure 1).

The facilitator asks for arguments and allows children to clarify their ideas. These are facilitation questions such as: 'Are you sure?, Why do you think so?, Who agrees?, Can someone rephrase this answer?'. The facilitator raises doubt when a consensus surfaces and asks for synthesis when the inquiry comes to an end. The dialogue is not a debate because the participants are not out to convince each other of an idea. Rather, the dialogue is a shared inquiry: children explore a shared question and thus participate in the study of a key idea.

Objects such as a glass of water with a 'broken' spoon or a 'black box' (a mysterious box that cannot be opened) help children couple hands-on activities to the philosophical questions. The hands-on activities provide metaphors or scientific experiments to discuss science (e.g., the black box can be used as a metaphor to explore how a scientist can/cannot make claims about things that can't be seen).

The dialogues engage children to think about science, scientists, and knowledge (see Table 1). Children are active participants, but because the environment of a science festival is a busy place it is difficult to keep the children focused on the topic. In the setting of a science festival, children seem to expect more entertainment.

Version 2: philosophical questions embedded in a cover story

For a second version, a story context is created to engage the young audience and make it less like school. The facilitator presents himself as an alien scientist (a

Table 1. Philosophical dialogue excerpt for the first version of the intervention.

Facilitator	Can a rabbit be a scientist?
Child A	No, it cannot, because a rabbit cannot hold a test tube.
Facilitator	Can't you do science without holding a test tube?
Child A	Mmm, yes, you can, but rabbits don't have a memory either.
Child B	Yes, they do, my rabbit in the living room remembers when a table changes places. And as soon as he discovers this, he starts to sniff at that place. He investigates with his nose.
Facilitator	Who agrees? Can you investigate with your nose?
Child C	Yes, I agree, actually a scientist uses all his senses. He looks with his eyes, he feels, he listens.
Child B	I disagree, I mean, you can use your senses to do science, but that is not enough, you also need to do experiments.
Facilitator	Can you do science without doing experiments?
Child B	I don't know… We can't do an experiment with dinosaurs and still scientists study them.
Facilitator	Can't you do an experiment with dinosaurs?
	…
Facilitator	Let's go back to the rabbit. Can a rabbit be a scientist?
Child A	Mm, well, I guess it depends on what you mean with the word 'scientist'. A rabbit can do some investigations, it can taste and perhaps compare carrots, but don't you need more?
Child C	A rabbit can investigate, he can know something…
Facilitator	So can you do science without knowing anything?
Child C	Mm. No mm, that depends. If you know nothing, it can be very fun to be a scientist, because everything you discover is new. But then, you never know what to think about the things you see, you need words to explain what you see.
Child D	Perhaps we always think that we know things. But what we know may be wrong.
Facilitator	How do you know that what you know is true?
Child D	Hm… I don't know… I mean, it is true when it helps people.
Child E	No, but sometimes we think that something helps, and it doesn't. A scientist can know something, because he or she can think, and he can see.
Facilitator	Can you always trust what you see?
	… (At this moment, a glass of water with a spoon is introduced to demonstrate that a spoon may appear to be broken even if it isn't)
Facilitator	Can you know that what you see is true?
	…

philonaut) who comes to earth to help him understand this planet. This story is buttressed by a Philomobile, a 1 meter long 'lander' helping him to fly through space (Figure 2). Its shape is vaguely inspired by the Mars Pathfinder and it has a trunk to collect objects.

Again, questions about science and a broad variety of 'scientific or metaphorical objects' guide the dialogue. The cover story of the alien scientist helps to question

Figure 2. Philosophical dialogue about science at the Ghent University Museum. The Philomobile is in the middle. Due to corona restrictions most participants and the facilitator were wearing face masks. (© GUM — Gents Universiteitsmuseum — photo: Michiel Devijver)

even the simplest ideas about science. After a brief hesitation, children easily accept the idea that the facilitator is an alien scientist. Participants respond with both a smile and a frown to the questioning approach, they experience a combination of puzzlement and inspiration. The dialogues quickly lead to an engaging exploration of questions such as: "*Can you study air if you can't see it? Are scientists discoverers or inventors?*" Short conversations stimulate the participants' sense of wonder and of alienation. "*Strange,*" a child replied "*I hadn't looked at it like this, this is so new. How do I know that what I know is correct?*". The puzzling moments, the discovery that you as a participant don't know as much as you thought you knew, inspire further dialogue (in philosophy this is known as elenchus: the realization that one's conviction is wrong as one experiences a cognitive conflict).

Every dialogue differs, but the key themes circle around knowledge and science (Table 2). The interventions vary in length from 30 to 90 minutes. What remains after the session is a sense of wonder. "*I go home with more questions*" many children say, or: "*I didn't know we knew so much… and so little at the same time*". Another child says: "*I would love to be a scientist and now even more so, there is still so much work to do…*" "*But perhaps you should become a philosopher of science*" his friend replies.

Sometimes children build on each other's answers by raising more questions (see Table 3). In their own words, children reconstruct age-old realist and constructivist ideas from the history of philosophy of science. And just as these philosophers did, children keep discussing the ultimately 'unsolvable' questions. Yet while doing so they take perspectives and develop ever more nuance. After a workshop, a child responds: "*I used to think that a scientist knows the answer to every question, now I realize that what a scientist says is not always true, he can still make mistakes. Actually, if you cannot make a mistake, you cannot be a scientist as ideas that cannot be challenged are not really scientific ideas*". Another child continues this idea: "*I want to investigate what I don't know. In school we learn what other people already know, here you learn something new*".

Table 2. Philosophical dialogue excerpt for the second version of the workshop.

Philonaut	Can people investigate invisible things?
Child F	Yes, we can study very small microbes that are in fact invisible?
Child G	Actually, that's not true, if we look at microbes, we see them through a big microscope and then we can see them.
Philonaut	Is what you see under a microscope real?
Child F	What you see is real, but perhaps it is also not real, because it is much larger than you know it is.
Child H	I think you can study invisible things; you can't see the things in the air, yet you can still study them.
Child I	You can't see gases in the air, but you can find traces of them in a machine.
Child G	But if you only see traces, then you can't be really sure that what you see is real. If I see tracks of an animal, I can still make a mistake. Tracks that look like tracks of a bear are not necessarily tracks of a bear.
	(. . .)
Philonaut	Can you study time?
Child J	Time is so strange. When I say 'now' it is already gone. Yesterday is gone and tomorrow is not yet born. The only thing that exists is now and it is already gone. So, how can we ever study the 'now'?
	(. . .)

Table 3. Philosophical dialogue excerpt for the second version of the workshop.

Child K	Science describes what is real.
Child L	No science is like a story, it is something you create.
Child M	Can a story be real?
Child N	How do you know something is real? How do we know science is real? Is science real?

The workshops elicit wonder and mental involvement. One of the parents says: "*I didn't know my children knew all this*". With a smile the parent continued: "*It was funny and very interesting, yet I am afraid you took the lid off, and the children will keep questioning me all night*". Parents discover how clear their children can think about science. Nevertheless, some children get frustrated in the process. "*My head explodes, it is too full of ideas*", they say. Others keep questioning "*Can you know so much that you don't know anything anymore? How do I know that what we know is true?*".

Discussion

How do you encourage children in informal learning settings to think about science? That was the challenge that was addressed in this case study. Focusing on these epistemological issues in informal science education was new in the Belgian context. It differs from the approach where science communication is equivalent to the communication of 'science ideas'. Whereas other workshops at the science festival focused on the mechanism of photosynthesis or the science of climate change or robotics, this activity allowed children to take a bird's eye perspective and reflect on the practices of science as tools to build knowledge. This corresponded well with the approach of the Ghent University Science Museum. This new science museum aims to help a broad audience to reflect *about* science by

focusing on topics such as the role of doubt or categorization in science [De Schrijver, Dujardin, Verschelde & Segers, 2016; Doom, 2020].

Rather than providing decisive answers, the activity stimulates non-stop thinking. While the scientific and philosophical background knowledge of children obviously differs from that of scientists or philosophers, engaging in these types of dialogues nonetheless fosters focused reflection. In this process the role of the facilitator or science communicator is crucial. The facilitator guides the thinking process. By taking the participants' ideas seriously and exploring the different ideas that surface, children discover how to think about science. The facilitator is not absent but guides the thinking experience of the participants.

As was remarked earlier, the children participating in the workshops were already interested in science. What children already know about science surfaces in the dialogues. Yet in the end, the children's prior knowledge of science (e.g. the examples children give to buttress their ideas) just provide stepping stones to explore different perspectives to think about science. In this regard, it is not necessarily the participants' knowledge that steers the dialogue, it is the way children use their (prior) knowledge to develop arguments that keeps the dialogue going. It is the facilitator's experience that the same philosophical questions can be introduced in many different age groups. For instance, the philosophical question 'Can you investigate invisible things?' may lead to different lines of thinking. One might answer 'no, you can't study something that is invisible, because you cannot perceive it', or 'yes, you can perceive things that are not invisible (such as sound)', or 'yes you can study the invisible by making it visible'. Children can than put forward different kinds of examples to illustrate these different philosophical positions. Though, the speed with which these perspectives emerge may vary among different groups, these distinct thinking tracks can emerge in dialogues with both younger and older children. In this regard, a philosophical dialogue is not as unpredictable as it seems because in different groups the same kind of perspectives pop up. As soon as these separate positions emerge in the dialogue, they provide a chance to question participants about philosophical ideas such as the relation of perception and reality (e.g. with the question: Is what you see (under a microscope) real?)

A wide age-difference between the children isn't easy for the facilitator. Some of them are obviously faster or more knowledgeable than others, which makes it harder for the facilitator to invite everyone to participate in the thinking process. And still, a wide variety exists among children who participate in philosophical dialogues. Rondhuis observes children's philosophical skills vary; whereas some are very capable in developing arguments, understanding another's perspective or coping with the absence of a final answer, others find it more challenging [Rondhuis, 2005]. This implies that some young children can be very involved in a dialogue while some older children are more reluctant to participate. In a way, a wide age-difference between participants can even be an advantage: it allows the facilitator to urge the participants to use very simple words to explain what they mean. And precisely these clear and simple arguments invite other participants to cooperate in the thinking process and forward their ideas [McCall, 2009].

This philosophical dialogue facilitation technique can be challenging. First, it is not easy for facilitators to take the Socratic stance. It is not easy for a communicator

who has specific scientific expertise to remain silent and only focus on the thinking processes of the participants. However, this Socratic stance is crucial in eliciting participation among participants, as it gives participants the sense that their ideas are truly valuable and relevant. Second, this approach is challenging when the facilitator hears misconceptions of or about science. Should the facilitator intervene and provide answers, or should the facilitator rely only on the answers that are given in the group? If we take a broader perspective, the question is asking what the role of a science communicator should be. Is a science communicator an explainer, a facilitator, a hybrid of both, or still someone else? Antonio Costa [2005] posed this question about whether explainers should explain and the discussion is not yet settled. It is worth noting that much of the participants' energy and focus diminishes as soon as the philosophical dialogue facilitator provides answers. This is an argument for a clear separation of the roles of the science communicator: either the science communicator is facilitating, or the science communicator is explaining.

The narrative used to frame the workshop helps children to engage in the reflection process. The Philomobile is an imaginary spaceship, the facilitator acts as a philonaut who lands on earth and tries to understand human knowledge. This 'alien perspective' allows participants to share a 'view-from-nowhere' and reconsider (epistemic) ideas they took for granted. The use of a narrative context, a story, engages participants even more than a simple inquiry does. This approach builds upon traditional 'philosophy with children'-activities where a story is used as a stimulus to enhance reflection [Haynes & Murris, 2012]. In a way, philosophizing about science is like taking an alien stance towards science, looking at science as if you are an alien scientist unfamiliar with the actual customs and accepted knowledge. This alien perspective may be especially tempting for children as it gives the inquiry with an estranging touch and provides a narrative that invites children to enter the reflective mode. It invites them to philosophize, to "*ponder the general questions we cannot decisively answer, where we grapple with ignorances we cannot readily overcome*" [Bakker, 2017].

The philosophical approach elicits more questions than answers, urging participants to keep on looking for answers. This can be frustrating as behind every answer there are new questions hiding. Some children who are very keen to know and understand the world express frustration when answering the philosophical questions. They express their frustration with new questions. However, perhaps frustration is not necessarily a bad thing here. One of the students participating in a philosophical workshop said: "*I'm cross, I still don't know the answer. If you can't give it to me, I will ask my parents, I will look it up online and I will keep looking for it*". Although this child expressed his frustration, he also demonstrated how his frustration may lead him towards further study [De Schrijver, De Poorter, Cornelissen & Anthone, 2018]. If frustration can guide further investigation, then it may not be such an unwelcome result at all. After all, isn't the frustration of not knowing (yet) what to think, and an eagerness to find out more, exactly what motivates many scientists? As questions and evolving ideas are fundamental of science, answers will always elicit more answers. When children participate in the philosophical dialogues, they are not only discussing what makes science science, they are in a way enacting science itself: they conceptualize ideas and learn to cope with questions that haven't got definitive answers. Clearly, science is never finished, and exactly this is what participants experience during these workshops.

Conclusion

Using philosophical dialogues at a science festival or science museum can provide a context for children to voice their thinking about science. The participants' contributions are key to making the activity a success. Even though the facilitator does not answer questions, the dialogic approach raises answers and new questions in the participants' minds. By making thinking about science explicit in the dialogue, children expose their own thinking about (the pursuit of) knowledge.

In the process of designing and redesigning the activities, we learn that even young children can think about science. The approach helps children to phrase questions about science, the world they live in and the relation between science and reality. What seems especially interesting for us is how the use of this novel storyline (working with the alien perspective) helps children discuss 'nature of science'. Using 'symbolic' objects allows children to visualize their understanding of science. The challenge is to find objects and activities that stimulate reflection about science.

The approach demonstrates how a combination of philosophy and science may lead to fruitful dialogues at a science festival or museum. This method can provide a (safe) space for the expression and investigation of conflicting ideas about knowledge. This case study also leads to more questions for future studies: how can an approach focusing on 'nature of science' be integrated in a permanent exhibition in science museums? What is the long-term effect of this approach on children's reflection and critical thinking skills? How do we stimulate reflection skills without promoting relativism or nihilism? And lastly, if there were aliens, what would they think about informal science education on earth?

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