Ice balloons

Intermediate

Stimulate problem solving	**Silver**	**Stimulate entrepreneurship**	**Bronze**
Stimulate creativity	**Gold**	**Informal learning enviro.**	**Bronze**
Stimulate critical thinking	**Platinum**	**Technology use**	**Silver**
Stimulate group work	**Silver**		

Practicalities

Preparation: 2,5u

Duration: 2u

Material needs:

- Ice Balloons (min 2 for each group)
- Investigation material (see below)
- Writing material and post-its

Group size range: 6-30
Ideal sub-group size: 3

Workshop made for: 12-16

Easily transferable to workshops for ages between: +16

Environment FabLab necessary: No

Educational area:
* Computer science
* Engineering
* Mathematics
* Music
* Science
* Technology
* (Visual) Arts
* Other

Precognition - Goal

This workshop is designed to help teachers support students in developing the skill of questioning. We hope you find this workshop useful in establishing a vibrant setting for teachers to learn and extend their practice. And it will manage to inspire teachers to become enthused by scientific inquiry again.

One of the most powerful ways for students to learn science is through questions grounded in their own curiosity. This Ice Balloons workshop introduces teachers to ways to stimulate that curiosity, elicit student questions, and move them in productive directions that can ultimately lead to investigations.

All inquiry begins with a question. Many teachers use kits and other hands-on science curricula as starting points for investigating questions in the classroom. When students use these curricula, the questions they investigate are often determined by the instructional materials. While many teachers have the sense that their students would be motivated to explore topics in greater depth if they could pursue their own questions, they may be hesitant to encourage students to do this.

What frequently deters them is a concern that students won't have many questions, that it would be impossible to investigate the questions they do ask, or that their questions would not be focused on the topic at hand. This workshop responds to those concerns by letting the participants explore freely and build up from these intuitive questions.

Preparation

Attention: You will need to make ice balloons at least two days in advance of using them.

Teachers of primary education who tested this workshop told us that it's a good idea to make the balloons with the children in two days in advance. Its boosts engagement and students are proud of their creations. They were eager to start the activity and look at the balloons they made.

When the Ice Balloons cannot be made on the location of the workshop itself, they can be transported to there in a Cool Box or similar suited container. A well-insulated box will keep the balloons workable for at minimum 6h.

It is important to experiment with making ice balloons at least one time before the actual workshop. There are many different effects to be created, and lot of it depends on the local conditions (type of water, type of freezer,...) for optimal effect. Since the quality of the ice balloons is essential for the workings of the workshop, it is of highest importance to have some redundancy in this preparation

process.

How to make Ice Balloons?

Ice balloons are water balloons that have been frozen and then peeled, revealing the beautiful ball of ice inside.

1. To make an Ice Balloon stretch a balloon over a faucet or the neck of a plastic water bottle. Slowly fill the balloon until it's about 15 cm in diameter.
2. Remove the balloon from the faucet or bottle and let any excess air escape. Tie the top of the balloon.
3. Place the balloons in a freezer for 48 hours or longer; refrigerator freezers work fine. After 48 hours, your balloons should be frozen solid. If not, give them another day. Also, check them for clarity. The most beautiful, intriguing ice balloons are at least partially clear with needle-like structures inside.
4. Leave ice balloons in the freezer until the last possible minute. Then peel the balloons to reveal the balls of ice inside. (You can use scissors to cut off the knotted neck and then peel back the balloon.)

Ice Balloon Troubleshooting

While the ice balloons used in this activity should be as clear as possible, a partly clear one is probably the best you'll be able to get. If your ice balloons are very cloudy, there may be several reasons why.

Cloudiness comes from anything dissolved in the water, including minerals or gases. The most likely impurity will be air. The more air you have in your water, the cloudier your ice balloons will be. If you have very hard water, which has a lot of minerals dissolved in it, you're also likely to get cloudy ice balloons. In this case, you can fill your balloons with bottled water. To keep the level of dissolved gases low, consider boiling your water, putting the cooled water in a 2-liter plastic bottle, and then filling the balloons

Variety in Effects

A clear Ice Balloon with some needle-like structures is a perfect start, but you can expand the looks and effects on the different ice balloons by using one or more (possibly simultaneously) of the following techniques:

- Let the balloons freeze while they are suspended. Create a structure (e.g. out of wood) where you can hang the freezing balloon inside the freezer.
- Let a balloon freeze while it is colored with dye
- Let a balloon freeze that is filled up with hot water (80° or more)

- Fill up one of the balloons with heavily salted water
- Fill up one of the balloons with sugar water
- Fill up one of the balloons with grenadine

Workshop Guidelines

Phase 1: Exploration Phase

Material needs:
Essential: *Ice Balloons, flashlights, scissors (for cutting balloons), magnifying glasses. Post-it and writing material.*
Salt, Sugar, Food coloring (one color), nail and hammer
Optional: *small tubs of water that can hold one ice balloon (floating test), laser pen, infrared temperature meter, hand drill,...*

Goals:
Skill Goals (**Blue**)
(S1) *Posing questions about stimulating phenomena*
(S2) *Observing without interpretation*
(S3) *Using tools to enhance observation*

Content Goals (**Green**)
(C1) Importance of asking questions in STEM classes

Background story:

Questions are the basis of all inquiry. Whether it's in the classroom or the research laboratory, investigations begin when we encounter materials and phenomena that we don't understand—that engage our curiosity and draw us into looking at something more carefully. The purpose of this workshop is to give you an opportunity to think more deeply about the role of questioning in investigating materials and phenomena. In the course of this exploration, you'll discover how to turn questions from ones that students can't investigate into ones they can. As a way of raising and investigating questions, you'll be working with ice balloons—spheres of ice made by filling balloons with water, then freezing and peeling them.

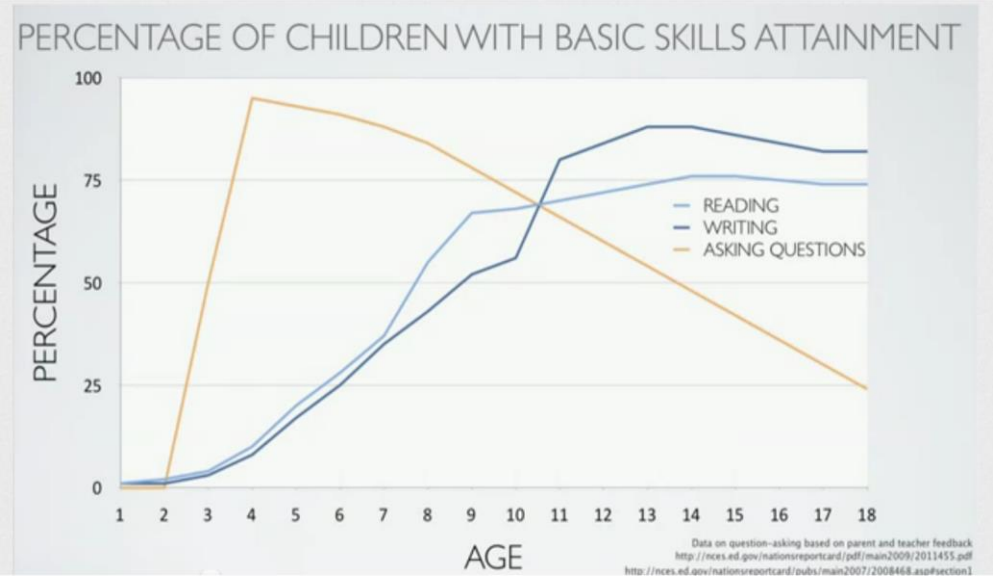
Although participants will learn something about the properties of ice today, the main focus of this workshop is to examine the process of raising questions. Through direct experience and discussion, they will develop an understanding of the key ideas and goals.

Goals	Activities	Duration
	Group formation Groups of preferably 3, maximum 4 are formed.	5 min

S1 S2 S3	**Exploring without touching (yellow post-its)** Participants explore ice balloons, write down questions about them, examine the variety of questions generated, and become aware of how interacting with intriguing phenomena can stimulate questions. Stress that they should are not (yet) allowed to touch the ice balloon. It can help you as a workshop organizer to use for each goal another color of post-its. We have written a suggestion next to each title. There are a number of features here that encourage close observation and stimulate questions. Turning off the lights for the first 10 minutes encourages the use of flashlights, which highlights the mysterious quality and beauty of the ice and draws people into the phenomenon. Participants note all questions they can think of (there are no wrong questions), one question per post-it. You can hang blank posters on the wall to put all the post-its on. Participants can use the materials mentioned above, but that should come organically, should not be a challenge in itself.	10 min
S1 S2 S3	**Exploring with tools and touching (pink post-its)** Turn on the lights. Tell participants you have some additional materials that they might like to use in exploring their ice balloons. Then distribute the sugar, salt, food coloring and nails and any additional material that you have brought for this purpose. Remind everyone to continue writing their questions on the cards.	20 min
C1	**Exploring the Question Space** Participants stop observing the ice to have a look at the variety of questions that came up during your explorative moments. Each group takes about 5 minutes to look through all the post-its and agree on one to read aloud. Let participants notice how many different questions came up. Even though everyone observed the same phenomenon, people saw very different things. Notice that the phenomenon was very simple, yet it was intriguing enough to	10 min

pique everyone's curiosity. Notice that there was ample time to observe, so a rich variety of questions could be generated by each observer.

Importance of asking questions in our education system can be brought up, using the graph and resources found below.



Phase 2: Investigation Phase

Material needs:
Essential: A new Ice balloon for each group.
Post-its + same research material as exploration phase.
Optional:

Goals:
Skill Goals (**Blue**)
(S1) ***Classifying questions***
(S2) ***Preparing an investigation based on research question.***
(S3) ***Express the findings of a investigation***

Content Goals (**Green**)

(C1) Difference between investigable and non-investigable questions
(C2) Turning non-investigable questions can be turned into investigable ones

By now, participants have had a chance to raise a variety of questions about ice balloons. In this part of the workshop, they sort their questions into those they think can be investigated and those that can't. Then they'll choose one question to investigate.

Investigable questions are the ones you think can be investigated by doing something concrete with tools and materials.

Non-investigable questions are the ones you think cannot be answered by investigating with tools and materials.

Goals	Activities	Duration
S1 C1	**Sorting** Participants take five minutes to quickly go through all questions and sort them into two piles. One pile should be for the questions they think are "investigable," and the other pile should be for questions they think are "non-investigable." It can help here again too bring everybody in front of a poster to do the sorting.	5 min
S1 S2 C1	**Choosing one**	10 min

C2	Participants choose one question from your investigable pile that they think they can take some action on, given the time and materials available.	
S1 S2 C1 C2	**Investigate** Tell participants: “Find out whatever you can in the next 25 minutes. In this limited amount of time, you probably won’t be able to fully answer the question you’re investigating. This experience is intended only as a sample of what it’s like to investigate your own questions. As you work, keep in mind that the questioning process hasn’t stopped. Jot down new questions that come up. If you don’t want to stop what you’re doing to write down your new questions, take a couple of minutes at the end of your investigation to record them. Always keep the investigation going. For didactical tips see below.	25 min
S3	**Ending investigation** Bring investigations to a close, acknowledging that this is an arbitrary stopping point and that people may not feel their investigation is finished. - let each group formulate a conclusion about the investigation and about the process itself (that they will share with the group afterwards). Our suggestion is to do it on orange post-its. - Clean up and give a short break (message: “*In your groups, take five minutes to discuss the question you investigated and the actions it led you to take. Then, identify the questions that came up while you were investigating and the actions you took as a result”)*	10 min + break

Phase 3: Presenting Phase

Material needs:
Essential: /
Optional: /

Goals:
Skill Goals (**Blue**)
(S1) ***Express the findings of a investigation***
(S2) ***Presenting the findings of an investigation***
(S3) ***Critically reflecting on a research process***
Content Goals (**Green**)
(C1) ***Typical moments and processes in the Question Cycle***

Goals	Activities	Duration
S1 S2 S3	**Presenting** Each group presents briefly their findings and how they approached the problem. Also identify the new questions that came up during the investigations.	5 min per group
C1	**Discussing the Question Cycle** With the group you discuss the question process and typical obstacles that will appear with pupils. Did anyone get stuck during the investigation? Why do you think your question didn't lead in a productive direction? What (if anything) did you do about it? What would you say is an essential step to take when going on investigation from an initial question?	10 min

Phase 4: What makes an investigable question?

Material needs:
Essential: Blackboard or whiteboard to write conclusions on
Optional: /

Goals:
Skill Goals (**Blue**)
(S1) ***Analyzing Questions***
(S2) ***Performing a Variable Scan***
Content Goals (**Green**)
(C1) Difference between investigable and non-investigable questions
(C2) Turning non-investigable questions can be turned into investigable ones
(C3) The characteristics of a Variable Scan

Now that participants have developed criteria for investigable questions, they'll begin to recognize the way language determines whether a question is investigable or non-investigable

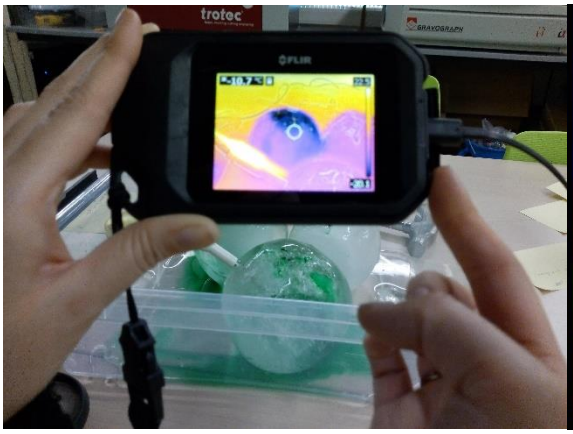
Goals	Activities	Duration
S1 C1 C2	Let participants use their post-its with investigable and non-investigable questions and look for linguistic characteristics between those. What makes an investigable question Investigable? (see didactical tips for more)	5
S2 C3	Usually they will have most of their questions classified as 'non-investigable'. Now let them discuss ways in which they can make those questions more suited for guiding a research. How do they do that? Introduce the concept of the 'variable scan'. "The term means you'll be scanning a non-investigable question to identify the variables in it—that is, examining it to find elements you can change in an experiment.	10

Phase 5: Conclusion

Material needs:
Essential: /
Optional: /

Goals:
Skill Goals (**Blue**)
(S1) /
Content Goals (**Green**)
(C1) /

Goals	Activities	Duration
	Conclude the workshop "You've just gone through a workshop in which you explored ice balloons, raised questions about what you observed, chose a question, and investigated it briefly. Then you identified the differences between investigable and non-investigable questions, and determined what makes a question investigable. You also learned about a technique called a "variables scan" that can help you focus on particular variables, so you can change a question that can't be investigated into one that can. Take-Home Messages ■ Interesting phenomena can stimulate a rich variety of questions. ■ Questions drive the investigation process. ■ Questions can either be investigable or non-investigable. ■ Non-investigable questions can be	5


trotec
FLIR


27.5 °C
33.0
17.8

Pedagogical tips

■ Offer Suggestions

If a group has trouble getting started, you might suggest particular materials they could use or some specific actions they could take.

■ Help Groups Remain Engaged

Groups having trouble staying engaged may have chosen a question that's quickly answered, such as "Does salt melt ice?" Or they may have chosen one that doesn't turn out to be very interesting. If time permits, you can suggest that participants find another

question from their investigable pile to pursue.

■ Listen and Ask Questions

Causally interact with various groups to find out what they're exploring. It's a good idea to start by listening carefully in order to get a sense of what the group is investigating. Then, you might ask group members to explain what they're doing or what they're trying to find out by asking questions such as: > What have you been working on so far? What have you found that's interesting or intriguing about ice? What questions are coming up as you investigate?"

About Investigable Questions

- Questions beginning with why are requesting information rather than suggesting an action that can be taken. Generally, these questions can be answered by using a reference book or the Internet or by asking an experienced person.
- For investigable questions, point out the implied action. Tell participants: > Investigable questions frequently begin with "What will happen if," or include the phrase "does the____ make a difference?" or "How does ____ affect ____ ?"The phrasing of such questions leads to taking some

action that would help answer the question.

If there are no appropriate questions, or if you would rather not refer to participants' work, you can offer this question as an example:

> Why does ice melt so fast when you put it in water? Ask participants: > What are the variables? (1. ice; 2. water or liquid) Next, ask:

> How can the ice be changed? (e.g., size and shape; how much it's submerged.) How can the water/liquid be changed? (e.g., amount; temperature; adding salt or sugar; different types of liquids) Now ask for turned questions:

> Can you come up with a question that involves changing something about ice? (e.g., What happens when I change the shape of the ice? Do lots of little pieces melt faster than one big piece?)

Can you come up with a question that involves changing something about the water/liquid? (e.g. What happens if I put ice in salt water? Does the ice melt faster in a quart of water or a gallon of water?)

How to transfer to non-Fablab environment

This was in a non-fablab environment. In a Fablab Environment possibly some self-made tools could be used for further investigation, of the characteristics of the ice as building material (with glue for example) could be explored. Although that would only have limited extra benefits

Evaluation of achievements

Groups can be rated on the quality of the questions asked and the quality of their research coming out of these questions.

Content links

Nation report card "asking questions"
https://nces.ed.gov/nationsreportcard/pdf/main2009/2011455.pdf

Richard Feynman: "why do magnet repel"
https://www.youtube.com/watch?v=36GT2zI8lVA

Resources

https://www.exploratorium.edu/snacks/ice-balloons

https://eatingrichly.com/ice-balloons/